A Report

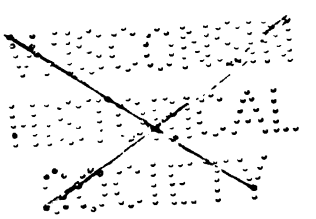
To the Street Paving Committee of the
Commercial Club

ON

The Street Paving Problem of Chicago

By
JOHN W. ALVORD, C. E.
Consulting Engineer

And an Opinion of John S. Miller, Esq., on Maintenance and
Repair of Chicago Streets



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The Commercial Club of Chicago, feeling that the public interests require a broader study and knowledge of the important problem of Street Paving and Maintenance in this city, appointed the undersigned committee on street improvement and authorized Mr. John W. Alvord, Consulting Engineer, to make an investigation and to report the facts and his conclusions.

Mr. Alvord's report, which we now publish, is not only very able, thorough, and conclusive, but has been written within a compass which makes what is really a treatise an easily readable pamphlet. It is well fitted, therefore, to disseminate in the community correct knowledge of the street question, and to incite intelligent interest in its practical solution.

The expenditure for paving has been, is now, and will be more and more, extremely large; and it is the wish of the Commercial Club to aid as it can to secure in return for this heavy outlay, really good streets, well maintained.

Mr. Alvord's suggestions as to a fund for maintenance is supplemented by the professional opinion of John S. Miller Esq., touching the best method, under present or contemplated laws, to secure such a fund.

We commend both Mr. Alvord's report and Mr. Miller's opinion.

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CHICAGO, May 6, 1904.

PART I.

THE PAVING PROBLEM IN GENERAL.

At the beginning of the century 24,000,000 of the population of the United States living in cities of 8,000 and over had invested approximately $850,000,000 in improving their streets with curbing, paving, grading, and sidewalks. Each year a further improvement of over $70,450,000 for such improvements and their care and renewal is made, and the amount is constantly increasing.

But one other class of engineering works exceeds this in magnitude, that of the steam railway system of the United States.

One would suppose that this vast output of human energy would be the occasion of the most critical investigation and scientific research, but it is safe to say that in no other branch of civil engineering is there expended so large an amount of money in so unsystematic a manner, and generally with such unsatisfactory results.

Pavements are primarily designed to accommodate travel, but scarcely any one in this country thinks of investigating the travel of a city systematically and thoroughly before proceeding to lay down pavements.

Pavements are financial investments, yet few officials undertake to compile data from which to compute their operating expense, length of life, or depreciation, before proceeding to raise the necessary capital.

Street pavements are by far the most expensive single improvement that the municipality undertakes, yet in hardly any of the cities of this country are there suitable laws, proper organization, or sufficient public spirit adequately to care for the investment after it is once made.

The improvement of streets is a legitimate method of adorning our cities, yet no one thinks of consulting recognized authorities on good taste in such matters, except in boulevards and parks.

Pavements have been a necessity of civilization since Rome was mistress of the world, but cities are still experimenting with the subject without general and well-defined policies. Community after community repeats the fundamental experiments, and copies without reflection or study what they see being done elsewhere.

The railways of the country know to a penny the cost in life service and the comparative utility of every bolt and scrap of iron that enters into their composition. They can tell you to several places of decimals the cost of moving a ton-mile of freight and the transportation of a passenger.

The city officials in this country that can make more than a rough guess of these matters in connection with the enormously greater travel of cities can be counted on the fingers of one's two hands.

Several things tend to explain this anomaly.

1st. The administration of American cities changes every few years. Omitting for the moment all complaint as to the blighting effect of partisan politics, settled policies producing advancement in the art do not naturally result from such constant change of direction. Seldom do officers of the municipality have the ambition or opportunity to become thorough masters of the broader requirements of the problems with which they are confronted.

2d. In a republican state the tax-payer is expected to have a deciding vote in the expenditure of the public moneys, especially those raised by local taxation. In the matters of water supply or sewerage, he feels his inexperience and is willing to be somewhat advised, but upon the subject of pavements, he has positive convictions of his own. In the smaller cities, the tax-payers interested nearly always decide upon the kind of pavement to be laid. In the larger cities their voice is still most potent; as a consequence, there is the entire tax-paying body to be educated, not only in the science of road-building, but the broader public policies of such improvements, rather than to leave the matter to a few trained and educated minds. As a result, advancement proceeds no faster than the education of the whole mass of tax-payers.

3d. Different kinds of street pavement rise or fall in public estimation with an undue amount of popular fluctuation. This is because there is no pavement that is perfect for all classes of conditions, and the pavement that comes the nearest to meeting one set of requirements will be the furthest away from another set of requirements. The public having selected a pavement, perhaps ill adapted to a particular environment and finding it there lacking in important particulars is apt to thoughtlessly, and perhaps pettishly, condemn it in toto when such a sweeping verdict is not warranted.

Even city officials in charge of such matters do not always investigate carefully enough the causes which make for failure, and allow personal impressions to take the place of carefully investigated facts.

4th. The engineering profession in this country, up to within a few years, have not generally interested themselves in the subject of street paving, because they have not been given very large opportunity to properly study the question. Finding the tax-payer a self-appointed, and sometimes exacting, expert, they have been obliged more or less to abandon the field, so far as its broader questions are concerned, to him and accept his dictum.

The specialist on street paving has been long recognized abroad as an important factor in municipal progress, and of recent years, he is beginning to appear in the United States. Seldom, however, does an average city call for his services, and almost never do municipalities appoint commissions of such men with ample funds to make an exhaustive study of the street-paving problem in its broader requirements.

5th. A natural distrust for municipal authorities is the normal condition of mind of the American tax-payer.

This is the inevitable result of a system that generally produces mediocre results. And nowhere are mediocre results more apparent and unhappy than in the work of street improvements.

As a result, the average city administration, however honest its intentions, feels that it is without moral support. It does not initiate broad policies, or spend public moneys, for investigation and research; it gropes its way in the darkness of chance, and plays its cards like an opportunist, postpones all possible trouble to its successors, blames all deficiencies onto its predecessors, while ever pleading for revenue for new experiments.

A distrustful public generally refuses to co-operate in legislation tending to increase taxation for the future, until absolutely assured of wisdom and economy in the present. The public is at times a harsh judge, and does not easily overlook glaring imperfections or fully analyze deficient results.

6th. The usual method in this country of assessing the cost of improvements to the abutting property has tended to give undue prominence to the property owner, as the representative of the public in deciding upon and paying for street paving.

As a matter of fact, the abutting property owner is an agent. Whenever possible he passes on to the rest of the community, in the form of increased valuation and rental of his property, the cost he is assessed. Often he recoups himself for his outlay, many times over, yet ordinarily he regards himself as a public benefactor, and as such claims the right to outline street policies which usually lead down to his own pecuniary advantage rather than that of the public.

7th. The method of assessing the first cost of pavements on the property owner, and then maintaining the pavement out of the public fund, has resulted in the majority of cases in there being little if any maintenance at all. No municipality has ever had an adequate "general fund." The general fund is the common prey of all the more novel municipal projects and ambitions, and the commonplace uses to which it might be administered will always be unduly curtailed.

8th. There is no general public appreciation of the vital necessity of maintaining pavements after they are once laid, and as a consequence, there has been no co-operation on the part of the public in framing legislation and raising revenues which must be devoted strictly to this purpose.

In France, where road-building is a science, the practice during the last twenty-five years has tended more and more to lessen the first cost of the national roads by decreasing the thickness of foundations and increasing the annual expenditure for maintenance. There are over $24,000,000 expended annually on 22,000 miles of national roads in France, equal to an average of $225.00 per mile per annum for repairs alone on country roads.

In this country, even in cities, the practice has been generally to build heavy improvements at high first cost, and allow them to wear out at a minimum of

repair. The improved streets of Chicago had expended upon them for repairs, in 1902, an average of only $41.75 per mile.

9th. And finally, the street-paving problem is everywhere regarded as a local neighborhood problem. Speaking broadly, the general public of this country has not yet come to regard it as a national problem, or even entirely a municipal problem, hence the lack of appreciation of the broader municipal requirements, and the insufficiency and lack of study of its fundamental principles. To this cause may be assigned the chaotic condition of the art and the incoherence of the data now existing, and the absence of any general principles which should govern the subject as a whole.

PART II.

THE IDEALLY PAVED CITY.

In order to be progressive on any subject we must first investigate ideal conditions, and then see how far they can be approximated from the practical side.

Let us first see what are the broad general principles which should underlie the street-paving problem, and how they must be applied to produce ideal results.

1st. Street pavements are designed, constructed, and completed for practical purposes. And hence the first requirement for the municipal scheme for the city should be a thorough study of its traffic conditions—past, present, and future—with detailed and exact surveys of its amount, tonnage, direction, and variation; not alone for the congested districts, but for the remote and unused streets. A census should be taken of all typical classes of streets, both in the business center, the unfrequented residence sections, and the outlying arteries of communication with the country. Such a census should be repeated at such frequent intervals, that all the facts connected with the city are thoroughly and exactly known, and can be compiled with the certainty that obtains at present in the population census, or vital and commercial statistics. Then it will be possible to find a basis for present policies and forecast the future necessities.

The French apportion their annual expenditure for maintaining the municipal and national roads in precisely this manner: For instance, on the national roads, once in six or seven years, a commission expends twelve months in ascertaining the exact amount of average travel, and their report is full of elaborate and carefully analyzed details. The 22,000 miles of national roads are divided into sections of from two to ten miles, each with its post of observation. There were 4,734 such posts of observation in 1894, and a record was kept for 24 hours every thirteen days during the year. Upon this data are apportioned, in proportion to the traffic, the $4,000,000 and over, which is used to maintain the magnificent highways which span France in every direction. The city of Paris pursues essentially the same plan, with some variations of detail. It is indeed difficult to see how any ideas can be formulated for the general improvement of the streets of cities without carefully compiled knowledge of this character from which to reason. Such information is a prime essential to the intelligent study of the street-paving problem of an ideal city.

2d. Having acquired a basic knowledge of the travel as above outlined, and carefully studied its tendencies and characteristics, it next becomes necessary to classify the streets in accordance with the requirements they have to

meet. Something more than rough generalization in the mind of the head official of the department is desirable.

Legally defined classes, carefully described and adapted to different uses, should be adopted by the proper legislative authority. The streets after careful study should be placed in the different classes, in accordance with their needs and requirements, both as to the amount and character of traffic, width of roadway, depth of foundation, and amount necessary for maintenance and repair. Certain varieties of pavement, adapted to the particular classification of streets, should be adopted, and each class specified, so that, for instance, a choice may always be had for any given amount of traffic, as to whether the extreme of durability or minimum of noise is to be desired.

A rough outline of a desirable classification might be suggested:

Class One. Congested Retail Business District. Team traffic of from 5,000 to 10,000 tons per day, largely lighter vehicles. Large pedestrian traffic at crossings. Desirable width of street 100 to 120 feet. Broad roadways with width between curbs, 54 to 60 feet. Subways for all pipes and conduits of the public utility companies. Solid foundations for pavements. Highest type of noiseless and smooth pavement regardless of first cost or operating expenses, selected from point of view of comfort and convenience to public. Grooved street car rail. Refuge stands at center of streets at cross walks, such as are usual in Paris on the Champs Élysées. Low curbing; frequent public comfort stations; occasional subway crossings for pedestrians; brilliant lighting; annual maintenance for cleaning and repairs, based on amount of traffic, and liberal in amount.

Class Two. Streets of Heavy Tonnage in the vicinity of docks, warehouses, depots, etc., without large working populations adjacent. Heavy traffic loads, aggregating 5,000 to 15,000 tons per day. Width at least 80 to 100 feet. Broad roadways, with width between curbs 45 to 60 feet. Pavements of the most enduring material, regardless of noise, on solid foundation, regardless of first cost. Refuge stands in center of streets at crossings. Fairly high curbings. Ordinary lighting.

Class Three. Second Grade Business Street, or a main artery of travel to country, carrying 1,000 to 5,000 tons per day of heavy loads. Wide roadways with width at least 50 feet between curbs. Medium depth of curb. Grooved street car rail. Subways for public utility companies. Durable pavements on solid foundations. Selection to be made with due regard to first cost and operating expenses.

Class Four. Fairly Well Traveled, High-Class Residence Streets. Traffic ten to fifty tons per day, largely light vehicles and delivery wagons. Fairly narrow roadways, width 26 to 34 feet between curbs. Ample grass plots, and proper tree planting. Pavements on solid foundation, smooth and noiseless. Selected with regard to cost of operation, comfort, cleanliness, and noiselessness.

Class Five. Unfrequented Residence Streets. Traffic nothing to five tons

per day. Very narrow roadway, with width between curbs not more than 18 to 24 feet. Broad grass plots. Abundant tree planting.

Such a classification as the above, altered as may be found desirable or necessary after reasonable experience, ought to be the basis of every well-considered scheme of street improvement.

3d. With an exact census of travel should come much more complete knowledge of the life of different kinds of pavements under a given amount of wear. If it were known, for instance, that upon a certain street with a certain number of tons daily travel, and a given amount annually spent for repairs, that that kind of pavement lasted a certain number of years, a large amount of guess-work and personal impression would be eliminated from the street-improvement problem, and we would know far more accurately how to select pavement for certain streets, so far as cost of operation was concerned; for knowing its life we could calculate its cost in terms of annual repair, plus sinking funds for renewals for any given condition. Our choice would then be narrowed down to the question of smoothness, noise, and other considerations of pure adaptability and comfort.

4th. It would be very desirable to know more about the tractive force which is required to draw loads over different classes of pavement. Some experiments have been made along this line, but they are not at all comparable to the magnitude of the interests involved, and are to a certain extent contradictory and inconclusive, owing to their limited number and range.

Most of the large railroad companies of the United States have found it desirable and necessary to make careful tests with dynamometer cars to determine the tractive force required on every part of their road, and it has been found desirable from a financial point of view, as a result of these experiments, to expend many millions of dollars in easing curves and reducing grades.

The street traffic of our large cities is quite an analogous problem. What we desire to know is not only the tractive force required on each different kind of pavement, but on the same kind of pavement under different conditions of temperature, dryness, or cleanliness. Also we ought to know how long the tractive force is necessarily increased by the reduction in smoothness in the pavement through wear. And a careful analysis of much experimental work, extended over a series of years, would give us a vast fund of useful information as to the economic possibilities of different classes of pavement for different kinds of travel. Such data would also indicate clearly the period in the life of any pavement when its wear renders it unfit for further profitable use.

Such experimental work is not expensive, and would undoubtedly result in a revelation to many officials who rely on personal impressions rather than ascertain facts. No systematic and long-continued work of this character has ever been undertaken in the United States.

5th. In an ideal city, pavements should be maintained adequately, not

only as a matter of good financiering, but as a matter of public convenience. It may be cheaper to build heavy pavements and let them go to pieces uncared for until they are rebuilt again. But the public wants and is entitled to have its pavements kept in proper condition for convenient and comfortable use. And no pavement which is allowed to deteriorate uncared for is in condition to be fit for travel.

It is fully as important, therefore, that an adequate revenue should be raised for the repair, as it is necessary to finance the first construction. Such revenue should be apportioned systematically throughout the city, largely on the basis of the street-travel census, on the theory that the wear of the pavements will be in proportion to the travel. In unfrequented streets, this is probably not entirely the case, and the elements and natural decay would have as much to do with the necessary repairs as would the travel.

The character of the pavement itself would also modify to some extent this method of apportionment, but speaking generally its basis has been found by experience to be safely indicated largely by the travel.

6th. An ideal city will not only select the pavement best adapted to the tonnage, but will regulate the width of its paved roadways to suit the amount of traffic. When the traffic is heavy, the roadway should be correspondingly broad. Broad streets are almost always desirable, but broad pavements are not by any means always necessary. In most of the cities of this country, an immense amount of money has been wasted in paving broad roadways on residence streets where light traffic prevails. Not only is first cost thus thrown away, but annual loss of cleaning, sprinkling and repairs, becomes very much larger than is necessary, and in so far as the grass plots are thus restricted, the street is thereby less beautiful than it would otherwise be.

Why it is that the American tax-payer should spend money so lavishly on broad and lonely pavements that do not hear the click of a horse's hoof but a few times a day, is somewhat difficult to understand. Possibly it is due to a feeling of local pride; more probably it is ignorance of the beauty of a proper street design adapted to the use it receives. It is easily estimated that in the city of Chicago alone, about $10,000,000 have been uselessly expended in disfiguring residence streets with an extra breadth of hot, glaring, and dirty pavement that is quite without any reasonable use, and which would cost to maintain and repair, a very large sum annually, if it were properly done. Not being repaired or maintained it renders the street just that much more shabby.

A width of eighteen feet affords sufficient room for a vehicle to pass, when another is standing on each side of the pavement — a rare occurrence. Most vehicles can be turned in an 18-foot space, and if occasionally one is obliged to go to the nearest corner, there is no great harm done. A turning circle in the center of a long block is easily introduced. Thus it will be seen that 18 feet is a very fair width for an unfrequented residence street, and a width from 20 to

24 feet is probably sufficient for the larger number of residence and suburban streets. A great number of streets in residence portions of our cities are one-third wider than these figures. The tonnage of the traffic in some of the business portions of Chicago rises to 15,000 tons per day, and is accommodated in some places on a 30-foot roadway, but there is hardly a residence street in which the traffic exceeds ten tons in this same time, and yet with this tremendous difference in traffic, we find but little allowance for difference of width.

7th. Good taste in street effect is quite as conspicuous as in art of any kind. Why do we not find more of it exercised on our residence streets? Let us keep the ugly high curbing to the lowest possible point. Let us depress the roadway well below the adjacent lawns, widen the grass plots, and narrow the roadway in accordance with traffic. Uniform planting of trees as is done by the municipality in Washington, D. C., would be highly desirable. The improvement and maintenance of the parkways, the sprinkling and cleaning of the streets under the direction of the municipality, and paid for by local assessment, would be a step in advance. And the advice of a landscape specialist as to shrubbery and planting in wide avenues with narrow pavements would not be money thrown away. Occasionally in streets of light traffic, a circular park lot can be introduced at an intersection without extra expense, as shown on the accompanying drawing. Not too often, but here and there, as opportunity is afforded.

Where traffic permits, why not solve the trolley rail question by making the central 16 feet of the street a grass plot, curbed off from the rest of the roadway by low curbing, and given over to the railway line. A crossing might be put into the middle of long blocks, and the sidewalk space on such streets ought to be somewhat narrowed to permit of increased roadway space. Such an arrangement is not always possible, but it is possible more often than would be suspected. Accurate traffic returns would tell us when it could be safely done. In Boston and St. Louis they lay out wide boulevards with special park spaces for the trolley, and they are delightful. Above all, let us have our residence streets cleaned oftener than once a year, as is the case now in Chicago. This can be accomplished. Anything can be accomplished if we are willing to have laws passed which will enable the municipality to charge us up with the price. It cannot be done for nothing.

8th. We find in Chicago a large number of improvement associations. This spontaneous growth is an evidence of a desire for clean and beautiful streets, and a willingness to pay for them, but they are doing work which should be done by the municipality had it the means, the energy, and the forethought, and more conspicuously than all the "careful methods." Such associations are an anomaly and a reproach. Something is lacking somewhere or they would not exist. It is not wholly the revenue question; it is very largely the citizens' distrust of the municipality's mediocre results, which inspires him to place funds and special work and support in these associations rather than to work to increase the revenues of the city government.

PART III.

PRESENT TENDENCIES OF AMERICAN AND FOREIGN CITIES.

The present tendency of American cities is distinctly towards more luxurious pavements in the sense that comfort and convenience are consulted as well as absolute necessity.

There is a period in the early growth of every young city when it comes to realize that pavements are a necessity. Then follows the tax-payer's hunt for the cheapest available pavement that will answer the purpose. After some years of growth and experience with pavements whose first cost is low, it dawns upon the municipal consciousness that pavements are like other investments. First cost is not the only factor, operating expenses and duration of life are necessarily considered. Generally, about this time it is found that solid foundations are a paying investment. Then more durable pavements, such as granite blocks, are substituted at larger first cost. A little later yet in municipal history, comes a demand for that which represents the height of comfort and convenience regardless of first cost. On busy streets, crowded with traffic, comfort and convenience supersede all other considerations. The very best noiseless, smooth pavements, excellently maintained, are none too good. The business condition warrants it, and the public desires it, and the tax-payer can afford it.

The City of Chicago has passed through the earlier stages above described. It first looked for pavements of low first cost, and discovered cedar blocks laid on planks. Some 740 miles of cedar blocks are now found on its streets. Some of these pavements have served their purpose fairly well, but their chief recommendation, low first cost, has been accompanied by short life, and a latter end whose discomforts are past all description. Therefore, about the year 1880, attention began to be given to more desirable pavements on business streets, and the central district was paved with granite. When this pavement was completed, we had arrived at the extreme of durability without regard to comfort or convenience. To-day there are signs of discontent, because as a city of the first class, we have come to a point in our history when we realize that in our central business district at least, with its large working population, comfort and convenience rank over all other considerations. We do a vastly greater business than we used to, and we are entitled to more quiet in which to work. We desire to walk across the streets everywhere on clean, smooth surfaces without having to pick our way, or be careful of our footing. As a city, we can afford such a condition in our business and retail center, and we are entitled to it. And let us not forget that everybody who toils in the business district helps indirectly to pay for the improvements.

This same stage of experience has been reached by nearly all of the larger American cities. Some of them realized it early, and are already provided with good, clean, smooth, noiseless pavements in the principal retail and residence quarters. Others are just awakening to the demand, while a few have hardly realized yet that they can afford a luxurious pavement. Chicago is in the latter class.

In the Eastern cities of this country, everything is tending to smooth, noiseless pavements, such as asphalt, asphaltic block, bitulithic or asphaltic macadam and creosoted wooden block. The city of Brooklyn is laying 30 miles of asphalt this year, Buffalo has over 285 miles in place; New York City is laying about 40 miles of asphalt, largely over the top of granite pavement, a method which has proved quite successful there and is worthy of especial notice. Boston, with its steep grades, is still conspicuously clinging to granite for business streets, but has notable examples in the principal thoroughfares, of creosoted rectangular wooden blocks, a smooth, noiseless, and valuable pavement. St. Louis is laying an asphalt macadam, or so-called bitulithic pavement, on several miles of the main approach to the exposition grounds. In 1900, the four cities of New York, Philadelphia, Buffalo, and Washington, contained 837 miles of asphalt pavement, while in January, 1903, the same four cities contained 1,033 miles, an increase of nearly 25 per cent.

A set of diagrams accompanying this report show the paving tendency in 135 American cities from 1890 to 1901, and gives the amount of pavements displaced and the kind of pavements laid. Further sheets show details for the 30 largest cities.

It will be seen that of new pavements, the following percentages were laid during the decade:

Asphalt	33 per cent
Brick	25 per cent
Macadam	23 per cent
Granite	8 per cent
Wood	7 per cent
Miscellaneous	4 per cent

Since 1900, the tendency is still more marked towards the smooth and noiseless pavements, not only for business districts, but for residence streets, where rental values are easily affected by the character of the pavements.

The larger European cities arrived at the point in municipal history more than a generation ago, where comfortable and convenient pavements regardless of first cost were deemed necessary.

In Paris, 50 years ago, all the pavements were either cobblestone, block stone, or macadam, the former in those sections where travel was heaviest, and the latter where travel was relatively light. As travel increased, block stone was

substituted until in 1894, 71 per cent of the pavements of Paris were of block stone, and only 16 per cent of macadam.

The desire, however, in certain sections for a pavement which would obviate the noise of the one and the dust of and mud of the other, has led to the introduction, first of asphalt, then of rectangular, close-fitting wooden blocks. Asphalt streets date from 1837, but it was not until 1855 that the methods of to-day were introduced. Wood pavements were first introduced in 1881 for the heavy traveled boulevards, and even ten years ago, there were 3.8 per cent of asphalt and 8.4 per cent of rectangular wooden blocks.

The tendency in Paris of late years is increasingly to substitute asphalt and rectangular wood block, mainly the latter, for block, stone, and macadam, especially for macadam. In certain outlying parts of the city, macadam will be retained, and in other streets from the nature of the traffic, block stone is still preferred, but the use of wood is decidedly on the increase, and it is obviously the favorite as it is accounted smooth, noiseless, agreeable to drive over, easily kept clean, and is rapidly relaid when worn out.

Asphalt is considered by the French engineers to have all these advantages, but it has the disadvantage of being rather slippery when wet. Its use is, in general, restricted to narrow streets less open to the sun and winds, while wood is laid on broader streets to which the sun and wind have free access. In Paris, horses at all seasons are shod smooth, a local custom, the reason for which is not apparent, as there seems to be no law requiring it. It undoubtedly diminishes the wear on both asphalt and wood, but necessitates the sprinkling of sand or gravel whenever the surface becomes slippery from any cause.

The excellence of the street pavements of Paris and the unusual amount of care bestowed upon them by the intelligent and highly educated officials in charge, justify the most careful study on the part of American municipalities.

In London, where wood pavements predominate for streets of heavy traffic and main thoroughfares, where comfort and convenience are demanded, and is the favorite pavement, creosoted blocks are largely used, but certain hard woods from Australia, known as karri and jarrah wood, are coming to be extensively used. It will be remembered that, both in London and Paris, the bulk of the traffic consists of large three-horse omnibuses, weighing about 120,000 pounds when fully loaded, with speed varying from five and one-half to six and one-fourth miles per hour. This traffic is very destructive to the pavement, and in American cities is entirely taken up by the street car rail, which, when not of the grooved pattern, also carries from one-fifth to one-third of other traffic as well as the passenger traffic.

The life of London wood pavements is estimated at from ten to twelve years under these severe conditions, but they are very carefully laid and maintained, and promptly replaced when they wear rough. Macadam and Telford pavements are extensively used in London, being laid and maintained by day labor at great expense.

In Berlin there is very little wood pavement, but the principal streets in the business portion of the city are paved with asphalt, which is well laid and maintained in constant good order.

Frankfort, Hanover, Bremen, Cologne, Leipsic, Dresden, and Hamburg are largely paved with stone block, but the principal business streets are paved with asphalt, and there is some wood pavement. Streets about docks, depots, and warehouses are invariably paved with stone block carefully laid on solid concrete foundation.

Most of the smaller English cities outside of London are paved with stone block. In Liverpool and Manchester there is an increasing demand for wood pavements, which are there considered a very desirable improvement, as the moist and damp climate of England renders asphalt a rather more slippery pavement than is the case elsewhere.

Glasgow and Edinburg on their older streets have carefully cut and set stone blocks laid on concrete and maintained with great care. Both are hilly, and therefore asphalt is limited in use to certain level streets where quietness and cleanliness is a desideratum.

Everywhere the main result is the same. So soon as wealth and population increase to the point where luxury and comfort can demand it, the economical and more durable pavements of stone and granite on heavily traveled streets give way to pavement of shorter life and higher maintenance cost, but of immensely greater comfort to the public in the cessation of noise, smoothness for traffic, and ease with which they may be kept in condition.

PART IV.

THE AVAILABLE PAVING MATERIAL.

While but little study has been made of the broader principles underlying the art of street improvement, or data on the traffic streets must sustain, a large amount of literature has been developed as to the materials of pavements, their constructive details and first cost. This is the only field which the municipal engineer has been allowed to occupy undisturbed, and he has covered it with great detail and minuteness, and placed on record a large amount of useful information. It is not the purpose here to do more than present, in a brief review, the salient features of various kinds of available pavements, so that they may be intelligently assigned to the various classes of improvements outlined in part two of this report.

In reviewing the literature of this part of the subject, it may be desirable, first of all, to note that a considerable portion of the information available is to be credited to the contractors for monopolies, or the promoters of property interests in materials, and therefore, while excellent in its way, subject, nevertheless, to certain bias, and should be accepted somewhat guardedly.

A second thought which cannot be too strongly impressed is that available information as to wear and durability of pavements is quite incomplete, because of the absence of data as to travel, amount of repair, duration of life, and accurate statement of final condition. As a consequence, while we have knowledge as to first cost, no one can have much foundation for exact opinions as to the expense of operation and renewal of pavements upon which all real comparison depends. Hence the great variety of empirical ideas which we find expressed on this subject.

A third warning may be uttered to those who have preconceived ideas on this subject. The apparent failure of pavement to meet expectations under every condition should not work final condemnation. Each pavement has its strong and weak points, and if placed in unfavorable environment will not develop its best qualities.

With these cautions it may be well to attempt to outline, in only the most general manner, the strong and weak points of some of the better known and well tried forms of pavement, bearing in mind that upon this subject there are recently published volumes of well arranged material accessible to any one who is interested in the matter.

Asphalt. Asphalt pavements are a popular, high class pavement, comparatively noiseless, reasonably elastic, smooth and cheaply cleaned, and reducing the force required for traction to a moderate amount. When unclean and wet they are more or less slippery, but nevertheless, even then, they give usually ample foothold for horses except upon steep slopes.

Asphalt itself is a variable material, the only reliable test of which is its action in the pavement. Such pavements have frequently failed, but it is to be remembered that the industry is new and has been rapidly developed in less than thirty years to the point where there are now about 2,000 miles of street, representing an investment of over $100,000,000, in this country alone. The wearing surface of asphalt pavement is composed of ninety per cent of sand or mineral matter, the asphalt being the cement that binds it into a tenacious and elastic coating. If, for any reason, such as improper preparation, age, or volatilization, the cementing quality of the asphalt disappears, the pavement disintegrates, cracks, and is rapidly worn or broken down. The general tendency of asphalt pavement to decay will be indicated by its loss of elasticity, during sudden changes of temperature, cracks forming during cold weather, and particularly during extreme drops in the temperature. This pavement is particularly sensitive to the action of the sun's heat, and to the combined action of rain-water, acids, oxygen, and frost. Under such conditions it gradually loses its cementing power. It is an interesting fact, however, that asphalt pavements wear better and last longer when they are subjected to a considerable amount of travel. The elasticity of the pavement seems to be promoted and prolonged by use. Asphalt pavements require a considerable plant for their preparation, and experience and care in their construction, and are not a cheap pavement, either in first cost or operating expense.

Owing to the uncertainties of the manipulation of asphalt, a large number of cities in this country have adopted the method of laying it under a guarantee for a period of five, ten, or fifteen years, during which time it is repaired at the expense of the contractor, and the amount so expended charged into first cost. This method confuses the data connected with operating expense, and as the periods vary in different cities, renders it difficult to make proper comparisons, especially as it is common to make the guarantee period uniform all over a given city regardless of whether travel is heavy or light.

This method of long guarantee periods has its advocates and its critics about evenly divided. The real problem of repair by the municipality begins after the termination of the guarantee, and is a question interesting many municipalities at this time. Should cities let out repair by contract, or should they establish their own asphalt plants, and do their own repair work? With such plants established, the further question is raised as to the expediency of the doing away with the guarantee period and performing all repair. A valuable recent report of Mr. Tillson, Chief Engineer, Street Department of Brooklyn, is of interest as bearing upon this question. The city of Winnipeg has successfully established such a repair plant, and in other cities, notably Montreal and Brooklyn, they are being urged.

Asphalt pavements, consisting of only a binder coat and finishing coat, are laid in New York City as a cover to the older granite and stone block pavement, and it is claimed that the roughness of the older stone pavements forms an

admirable bed for the asphalt coat, from which it does not easily detach itself, as would be the case with smooth concrete foundation.

Finally, then, asphalt pavements are particularly desirable on high class residence streets, public squares, and retail shopping streets, and even wholesale streets, with heavy traffic when noiselessness is to be desired. They are not unduly expensive for unfrequented residence streets when the width of roadway is adapted to the amount of travel. Asphalt pavements are not economical on streets of excessively heavy traffic, such as occur in the vicinity of docks, freight depots, and warehouse districts with a large amount of heavy teaming, and they are particularly to be avoided in the vicinity of street car tracks using the old-fashioned flat rail.

Stone Pavement. Granite and stone block pavements have been the pavements in earliest and most common use. In their recent form they were introduced into this country about 1850. When carefully cut and set granite blocks are laid on solid foundations of concrete, it forms unquestionably the most durable pavement known, and has been the standard pavement of most European cities. Such a pavement is less laid than formerly, and the output of granite block has decreased one-half of recent years; asphalt, brick, and wood taking their place to a large extent.

It is found that the hardest stones will not necessarily give the best stone pavement, since a very hard stone usually wears smooth and rounded, and becomes slippery. A hard stone may be necessary under very heavy traffic, but under medium traffic a soft stone may give more satisfactory results.

Stone pavements, as laid in Chicago, after some wear become smooth and uneven. They are difficult and expensive to keep clean, and afford a very poor foothold for horses in wet weather, the hoof constantly slipping back until the calks engage a joint. But one of the greatest objections to stone pavements is the noise produced under heavy or medium travel. Such pavement will tend to reduce rents in residence streets which are much traveled, and are objectionable for the same reason in quarters of the city devoted to office buildings, the vicinity of large working populations or industries where quiet is desired.

Stone pavements are, therefore, desirable only in streets of the heaviest freight traffic, such as are described in Class II of this report, as being in the vicinity of docks, coarse freight warehouses, freight depots, and streets where very heavy trucking is necessary, and where noise can be tolerated. They are also a desirable pavement to lay in car tracks, as no other pavement so easily takes up the peculiar shocks, and is so readily repaired, in such situations. They are also well adapted to steep approaches of bridges and viaducts. European cities take more care of the dressing of stone blocks for pavements than is the case in this country, so that the blocks fit more closely together. In many cities, notably in Liverpool, the size of the blocks are reduced to a dimension more suited to the foothold of horses than is the case with the blocks used in Chicago.

Brick Pavements are a comparatively old form of pavement which has had

a notable revival developed out of the necessities of the central western part of this country, where suitable paving material is deficient over very large areas. A new industry has practically been created in the last fifteen years, until there are now nearly two hundred plants devoted to the manufacture of paving brick. Most of the smaller cities of the Central West early in 1885 to 1890 paved their business streets with brick, and the larger cities following, Philadelphia being in the lead to-day with over one hundred and thirty-five miles of brick pavement. In all parts of the country the use of brick for residence and light traffic business streets is rapidly increasing, and about as much brick pavement is now in progress as granite block, asphalt, and wood combined.

A vast amount of experience has been accumulated upon the manufacture of tough, selected clays into suitable paving brick, and its construction into competent pavements. The pavements of to-day are a great advance over the earlier experiments, and are very satisfactory for even fairly heavy traffic.

Brick pavements afford a good foothold for horses, and do not become slippery by wear. They are adapted to all grades, and some experiments by Prof. I. O. Baker seem to show that the tractive force required upon them is less than upon asphalt. This must be in comparison with soft asphalt, rich in bitumen, such as is adapted to carry out long-term guarantees. Brick pavements are easily and economically cleaned, and are easily repaired. They may be laid in connection with street car tracks without disadvantage, and are not so expensive a pavement as asphalt or granite.

Brick pavements are perhaps not adapted to the heaviest travel, and are not as noiseless a pavement as asphalt or wood, therefore they are adapted to the classes of streets III, IV, and V, described as second-grade business streets, arteries of communication with the country, and possibly, in some cases, well traveled high-class residence streets. They form an excellent material for the pavement of alleyways, courts, and squares, and in general are an excellent intermediate pavement as to durability between the granite block of heavy traveled streets and the macadam of country roads.

Wood Block Wood block pavement, as known to Chicago, consists largely of round cedar blocks with the spaces filled with gravel and coal tar. The remains of seven hundred and thirty miles of such pavement still exist upon the streets of the city, most of which has been in wretched condition for some time past. The main and inherent defect of circular wood block pavement is the fact that very wide spaces occur at most points between the blocks, the result of which is that the edge of the circle is quickly worn down, and the block becomes rounded or conical in shape. So soon as this result is reached, all the comfort and ease of the pavement is gone, and unfortunately only a moderate amount of travel is necessary to bring the pavement into this condition. Repairs are of little or no avail, as they cannot be made so as to replace the comfort of the original pavement, or even lengthen its life to any considerable extent.

The second fatal error of judgment has been that the proper use of wood pavements has been entirely misunderstood in Chicago.

Wood pavement fails either through excessive wear or natural decay. Unless the wooden blocks are of hard material, or are protected by some preservative process, their life is comparatively short in any event. The cedar blocks in use in Chicago, although more durable in wet ground than any other wood, have generally contained from twenty-five to thirty-five per cent of sap, which renders them less durable against decay, and of less strength to resist crushing under traffic than hard wood. But wood pavements in Chicago have been placed in environments entirely unsuited to the peculiar advantages of this form of pavement. Miles and miles of street have been paved with cedar blocks where there was little or no travel to be carried, and the result has been that the pavements have decayed away rather than worn out. Such light traveled streets should always be paved with a material which will not naturally of itself deteriorate, so that the renewals due to the wear of travel only would be necessary, and wooden pavement, if used at all, should only be used by laying close fitting wooden blocks upon streets of heavy travel, where the wear will terminate its life before decay sets in, and where its obvious advantages as a smooth, noiseless, and comfortable pavement can be most appreciated. This is the way wood is successfully used in London and Paris, where rectangular, close-fitting hard wood or creosoted blocks are laid upon a solid bed of concrete, forming a pavement which wears down without rounding the blocks, or even becoming very rough. Such wooden pavements, properly laid, are the favorite high-class pavement abroad, and that, too, under conditions where travel is far more heavy than anything we have in Chicago.

Quite recently the city of Chicago has laid down two samples of creosoted wooden blocks after the London type. One of these is on Michigan Avenue, in front of the Auditorium, which was put down in 1901, and is well worth inspection by those interested in this subject. Another sample is to be seen upon the Rush Street bridge. The life of such pavements in London under heavy traffic has been known to exceed nineteen years, and loans upon them are permitted up to twelve years and as they are only laid where they will wear out rather than decay, they form an admirable high-class pavement, and are carefully kept in repair and promptly renewed when necessary.

It is probable that the City of Paris has to-day over seventy-five miles of such pavements in the central streets of heaviest traffic. These have cost, on an average, about $3.47 per square meter, and the cost of maintenance is about 29 cents per square meter per year. The City of London has perhaps over one hundred miles of such pavement in use on streets whose travel is much greater than anything we know in this country.

The City of Indianapolis has a considerable amount of creosoted wooden

block pavement, which has been down some four or five years, and which are said to be very satisfactory. Its use is extending there.

With a few other notable exceptions, wood pavement is at the present time in disrepute in the central states, due to its misuse on such a large scale as has occurred in the past twenty years in Chicago and other Western cities. It is believed by many conservative engineers and city officials that this disrepute is unwarranted, and that wood pavement properly protected and suitably laid on solid foundation has its field of usefulness as a convenient, noiseless, and comfortable pavement in streets of heavy travel, where first cost is not the most important factor, and where the highest kind of comfort is demanded.

Macadam. Macadam, or broken stone pavements, were originated in England, and are universally used as the pavements for country roads. They consist essentially of several layers of crushed stone varying in size from large cubes at the bottom for the foundation course, to fine crushed stone as the binder or finishing course. When well wet and rolled with a heavy roller, the entire body is compacted into a more or less solid mass which forms admirable surface for light or unfrequent travel.

Macadam pavements are not, strictly speaking, a city pavement, as they are not adapted to the conditions of heavy travel in city streets. Their principal objection is a rapid wear, which produces accumulation of dust, requiring them to be almost constantly sprinkled.

In wet weather the dust is converted into thin pasty mud, all of which is out of place in a city street. Nevertheless, there is a large outlying area in every city where the travel is quite infrequent and the character of the street shades off into the type of country roads. In such localities a macadam street is both desirable and appropriate.

Where travel is so light that pavements commonly subject to decay would have their life terminated from that reason rather than from actual wear, macadam forms a pavement low in first cost, and which may be renewed from time to time without being rebuilt. It is, therefore, the pavement of all others to be used where first cost is an important consideration, and in districts where the lightest travel prevails, and where some dust and mud may be tolerated.

The laws of most of the cities of this country are totally unsuited to the use of macadam pavements, because they do not provide funds for adequate maintenance and repair. The result has been that in providing for macadam pavements engineers have been accustomed to providing very thick and expensive pavements in first cost with the expectation of giving them as long a life as possible under ordinary conditions of neglect. The result has been unfavorable to the popularity of macadam, as might be expected. Indeed, no pavement survives criticism under such circumstances.

Much may be learned about the proper construction and maintenance of

macadam pavements from the studies of French engineers, who have brought this branch of road-making to a high state of perfection through elaborate tests, reports, and long experience.

The Massachusetts Highway Commission has also done much in the last four or five years to determine the best kind of stone, proper thickness, and construction of macadam roads, and their reports should be consulted by every student of this subject.

Macadam pavement, then, should be confined to parks, boulevards, and the lighter, unfrequented classes of residence streets and the suburban portions of great cities included in class V.

Bitulithic Pavement. A new form of pavement, known as bitulithic pavement, or bituminous pavement, has been successfully introduced in the last few years, and is causing great interest among paving officials.

It consists essentially of broken stone so graded as to size that the voids are brought to a minimum. The stones are then heated, and mixed by machinery with a bituminous cement essentially like asphalt. The mixture is hauled to the street, and while still hot spread on the foundation so as to give a uniform thickness and grade and rolled and re-rolled with a heavy steam roller. The pavement appears to have all the elasticity of asphalt, although it does not present so smooth a surface. It gives apparently a better foothold for horses, with, nevertheless, a low tractive resistance. It seems to be adapted to much steeper grades than is asphalt, and it is claimed that it has a much harder wearing surface and a longer life.

None of it, however, has been in use long enough as yet to demonstrate its wearing qualities and durability under heavy traffic, but the promoters state that over 1,500,000 square yards are now laid or under contract in some fifty cities of the United States and Canada.

This pavement is being laid on the Dell Mar Avenue, a principal street leading to the fair grounds in St. Louis, and has been under observation on exceedingly steep grades in Boston, Mass., near the State House, where, after nearly two years' use, it is still unmarked by travel. Such a pavement as this would seem to be a logical outgrowth of experience, and must inevitably have an interesting future.

Summarizing, then, the available pavements for the city of Chicago, we may note that granite block should be reserved for a few of the heavy traffic streets around depots, warehouses, and docks, where noise may be tolerated, and between railway tracks. Asphalt may be desirably used upon retail business streets with a large amount of traffic, and wholesale streets with large working populations desiring quiet, streets devoted to office purposes, public squares, and the vicinity of institutions and hospitals, high-class residence streets with considerable traffic, and medium residence streets well traveled.

Wooden block pavement, of the London and Paris type, laid on solid foundations, might be desirably used wherever asphalt is used, with a restriction that

it be not laid upon streets not heavily traveled, where its life might be terminated by decay rather than by use.

Brick pavements are desirable for second-grade retail business streets, streets with car tracks, arteries of traffic where some degree of economy is desired, and residence streets where the tax-payers do not object to the noise.

Macadam should be relegated to the least traveled streets and the outlying districts, parks and boulevards and suburban roads.

PART V.

THE LOCAL PROBLEM.

The City of Chicago had, at the first of this year, 1,371 miles of improved streets and alleys for which, including renewals, she has paid approximately between sixty and sixty-five millions of dollars.

She is expending annually, the last few years, not far from $2,250,000 in the construction of new streets, and about $340,000 for their cleaning, maintenance and repair.

The street pavements are classified as follows:

708 miles of cedar block	equals 52	per cent of the total.
421 miles of macadam	equals 31	per cent of the total.
132 miles of asphalt	equals 10	per cent of the total.
68 miles of brick	equals 5	per cent of the total.
38 miles of stone block	equals 2	per cent of the total.
4 miles of other	equals	per cent of the total.
1,371	100	

Speaking generally, the 708 miles of cedar block pavement represent an investment of about $15,500,000, all of which, probably, must be replaced within the next few years. Probably 80 per cent of it is in a condition unfit for travel at the present time. Most of it should have been replaced some years ago. It has largely rotted out rather than worn out, and it has been a most unfortunate and injudicious investment.

The 421 miles of macadam probably represents an expenditure of about $3,400,000, a large amount of which would be a profitable investment were there sufficient maintenance, or care taken of it. Much of it is now worn very thin, and must be replaced at an early day.

Some macadam has been placed on streets for which it is probably not well adapted, because the travel is too great for its profitable use, and the wear is excessive.

A great deal of it is in an unsightly and uncomfortable condition, owing to lack of repair. A portion of the investment, however, is intact, and could be put into shape to be presentable at reasonable expense.

Of the 132 miles of asphalt, representing an investment of, say $7,400,000, much is in excellent shape. Some of it has been, and is being, ruined by the presence of the old flat street car rail. Some of it has been placed injudiciously. A little has not stood the severities of this climate, owing to lack of experience in manu-

facture and construction, but in general the investment has been a satisfactory one, and will be added to largely.

The 68 miles of brick pavements represents an investment of about $2,450,000. Some misapprehension of its characteristics has led to a portion of it being used in wrong places. A little of it has been laid upon streets with exceedingly heavy travel, where it has not had opportunity to earn a good reputation. Some of it has been laid on high-class residence streets, where its noise has not made it popular. Most of it, however, has been a good investment, and it will doubtless be added to largely.

Thirty-eight miles of granite streets have cost about $2,600,000, and mainly cover the business center of the city.

Along the docks and around the freight depots the wisdom of the investment has been fully justified, but in the retail shopping district and among the office buildings the sentiment is strongly in favor of something better, more noiseless, smoother and more perfectly cleaned. In New York City they are covering such granite pavements with sheet asphalt, and find it does excellently. There are some difficulties in applying this plan to Chicago streets, but the objections may be overcome by further study. In London and Paris they would repave such street with rectangular hard-wood blocks, perhaps creosoted. This could be done upon the present foundation without difficulty.

There is a chance for the new bitulithic pavements under proper and suitable guarantee for the business districts, probably upon the present granite block as a base. Any such plan involves changes in the level of the street car rail, and readjustment of gutters, and may prove not to be entirely practical.

Reviewing the matter, then, it would seem that about eight-tenths of the cedar block, one-fourth of the macadam, and two-thirds of the granite pavement must be relaid, and Chicago is facing the expenditure of not far from $16,000,000 in the next two or three years, the largest portion of which is to make good the poor judgment of the past. If there is added to this amount the sum of about $10,000,000, which has been wasted in abnormal width of paving in unfrequented roadways, there is about $26,000,000 to charge to want of foresight and lack of study on the part of the citizens. Truly, a pretty good sum for the local tax-payer to pay for the democratic privilege of selecting his own pavement from the depths of his inexperience.

In addition to the repairing to make good past errors of judgment, there is a large amount of current paving that the city requires to extend its street system. On the first of the year there were 1,529 miles of sewers and 1,918 miles of water-pipe, while there were only 1,371 miles of improved streets and alleys. This means that there are at least 150 miles of streets not now paved which have a sufficient population to be provided with water and sewers, and are next expecting pavements.

This will result in a probable expenditure of $6,000,000 in the near future, in addition to the repaving of worn-out streets, which has before been discussed.

DESTRUCTION BY CORPORATIONS.

During the year 1902 no less than 20,200 permits were granted to the public service corporations of Chicago to tear up the pavements. Chief among them was the gas service, with over 14,000 permits. A total of 200,000 square yards of pavement were thus disturbed during the year, equal to about ten miles of street thirty-six feet wide. In other words, an equivalent of one-sixth of all the new pavements laid by the city in 1902 was torn up by the public companies.

The money it cost to tear up these ten miles of streets every year would have built six miles of subway, and in ten years complete a subway system which would have covered many of the heavily traveled streets of the city.

This is one of the practical difficulties the gentlemen at the City Hall have to meet. It is not a theory, but a condition, and it accounts in large measure for the uneven appearance of many of our most expensive pavements. Paving cannot be cut into and replaced and leave it as before. Always such opening develops a weak spot which, in time, will yield to the weight of travel.

The evil has been done. The public utility companies have their contracts, and many of our downtown streets are so full of their pipe cables, manholes, and ducts that there is really no proper room for anything more.

THE STREET CAR RAIL PROBLEM.

Immediately in front of the Tribune Building, in Dearborn Street, is an excellent example* of the destruction of a good pavement by the old-fashioned flat rail in use by the Chicago Street Car Companies, and also at the same time an object lesson of the protection which would be afforded by the use of a grooved rail.

The easterly track at this point is of the former variety, while the westerly track is laid with the improved grooved rail.

A little over a year ago a new asphalt pavement was laid at this point, and adjacent to the flat rail track are three deep ruts already cut through the wearing coat of the asphalt. Two of these ruts are made by the broad gauge teams running with one wheel in either the inner or outer rail respectively, while the third rut is made by a standard gauge team running with one wheel in the outer rail. On the opposite or western, track, which is laid with improved grooved rail, there are no visible signs of any wear of this kind.

It is quite impossible to expect to lay high-class pavements in the vicinity of the old-fashioned flat rail and have them last any length of time, and this is one of those simple experiments which, it appears, have to be tried over and over again without really teaching the taxpayer any useful lesson.

There are, however, two sides to this story. It is quite remarkable to notice how much traffic is carried on the street car rails. One of the annexed tables, consisting of thirty-four observations, shows that very nearly two-thirds of the teaming on streets provided with flat rail tracks is carried upon the rails.

*Since this report was written this spot has been repaired.

In many instances this is because the pavements are so bad that the travel is obliged to seek the tracks; but in any event pavements are saved just so much wear, which would come upon them were the tracks not of a character to accommodate the traffic.

In all of the main arteries coming into the city which are provided with street car tracks, one may observe the tendency of the travel to seek the tracks.

A great deal has been written about steel wheel ways on turnpike roads leading out of cities, and some experimental sections have even been built and pronounced failures. But in the use of the old-fashioned street car rail we have a successful example of a well-patronized steel wheel way on almost every thoroughfare leading out of Chicago, and there can be no doubt that an enormous amount of wear is removed from the pavement from this cause.

When it comes to the higher classes of pavements, however, and especially when travel becomes so frequent that teams cannot always get back into the tracks for any length of time, they are content to ride with one wheel in the track and the other wheel out, and very quickly ruin anything but a granite pavement.

The only remedy for this condition lies in the judicious application of the grooved rail.

This difficulty has been well understood at the city hall for years, but negotiations with the railway companies have not so far been productive of results.

We will continue to lay down expensive pavements and see them torn to pieces because of the city's inability to insist on a great public corporation using the prop form of rail.

THE PROBLEM OF MAINTENANCE.

We are all more or less familiar with the inadequate revenues which the City of Chicago has to clean, maintain, and repair its streets, and a great deal has been said upon this subject of recent years. An annexed diagram of the principal cities of the country, their revenue and expenditure for this purpose, illustrates fully the fact that Chicago does not have enough money to expend upon her streets. But it is to be very much doubted if the maintenance of streets in proper repair will ever be successfully and satisfactorily accomplished with the most ample revenues unless some better system than the present one is adopted.

Any general fund for cleaning and repairs in Chicago, however adequate, is a delusion, because no general fund in so large a city is ever satisfactorily administered. There is needed specific territorial appropriation, local interest, and a local sense of responsibility in the expenditure, and a certain thoughtful care in detail, to properly use moneys for such purpose. A general fund administered from a central authority commonly has none of these features.

What is needed therefore is:

1st. Proper and adequate amount of funds for the purpose of cleaning and repair, and it may be suggested, for the purposes of discussion only, that rather

than amend the laws so as to provide for larger general funds, that the special assessment laws could be amended so that local taxation could provide for the cleaning, sprinkling, and repair of the streets, including the maintenance of the parkways, care of the trees and sidewalks.

Such an idea may prove to be objectionable and illegal. It is mentioned here only suggestively, but it would seem to have some obvious advantages.

Such special assessments might be incorporated into the original ordinance for the street improvement, so that when the question had once been taken up in any given locality, the annual cost of maintenance in a clean, orderly condition, would be settled for a term of years at the time its original cost was provided for. A certain amount of local interest would be thus assured on the part of the local tax-payer.

It should be noted in this connection that the planting of trees and sodding of parkways is just as much a part of the improvement of streets as curbing and grading the roadway, and might always with profit be included in the same ordinance.

2d. If the above suggestion is illegal or impracticable, and the funds for cleaning and repair must be provided for in a general way, some systematic method must be adopted for their proper distribution and thoughtful expenditure.

Here, again, the methods of the French appear to be the best that can be devised, and it would seem that the appropriation for this purpose ought to be authoritatively distributed by the proper legislative body to the different thoroughfares or districts in proportion to their importance as indicated by the amount of travel or character of improvement.

Once so distributed, the object ought to be to secure a certain amount of local interest among the tax-payers as to the careful and proper expenditure of the maintenance fund.

The local superintendent or road man might be appointed by the central authority upon the advice and consent of an association of tax-payers of the thoroughfare or district, who should be made responsible parties to the expenditure.

In such case there would be the personal interest of the local committee, which ought to insure thoughtful work and care in the expenditure of the fund.

The real basis would then become the spirit which now inspires the local improvement associations in their work, that is to say, a local pride and responsibility.

Under present conditions we see magnificent improvements made at a large first cost neglected from the day of their completion. Manholes protrude above the pavement, crosswalks become elevated so as to cause great annoyance to teams, curbs settle out of place, holes begin to appear, and the street assumes generally a shabby and neglected look within a year or two after it is finished.

It is well understood that certain classes of improvements to streets in Chicago are made unusually heavy and proportionally expensive because it is expected that

they will receive almost no care from the time of completion until tax-payers are driven to petition for a new pavement. This results in the injudicious use of public money, but it is still more unfortunate that it lowers the public ideal of what a street ought to be, and makes Chicago citizens apparently content with what impresses the visitor as unkempt, shabby, and neglected roadways.

INTELLIGENT DIRECTION.

The City of Chicago has already spent many millions of dollars wastefully upon its public streets. It has already spent enough money to be a well-paved city, but it has spent that money uneconomically and without careful study or proper advice.

There are accomplished, intelligent, and educated engineers in the city hall who understand paving problems, but their assistance is not often sought. Their time is filled with innumerable petty details, and the tax-payer has for years insisted upon his right to decide the kind and cost of paving of his street as a local and neighborhood question, and has resisted the attempts of any city administration to force upon him anything like a general policy with reference to the paving question of the city as a whole.

Chicago stands at the parting of the ways. She is facing the expenditure of fully sixteen millions of dollars to repair the mistakes of the past. Will she now stop and consider, and perhaps employ competent, expert advice as to how it should be expended, and will she believe that any thoughtful policy of a broad and general nature is a wise guide for the future?

The Board of Local Improvements ought to have, as their adviser, the best consulting expert on street improvements that can be found in the United States. Such a man ought to study the Chicago problem broadly, attentively, and thoughtfully, in the light of all the best European and American experience. He should secure advice of the best experts that can be found the world over on special problems, and should view the subject in its broadest economic and social requirements. The Board of Local Improvements, thus advised, should arrange a general policy of improvement, outline methods and classify the streets, designating the kind of improvement to go with each class, recommending such legislation as will enable adequate maintenance to accompany all construction, and see to it that some system is devised by which such maintenance shall be skillfully, thoughtfully, and persistently carried out.

Respectfully submitted,

JOHN W. ALVORD,
Consulting Engineer.

CHICAGO, October 9, 1903.

AN OPINION

OF JOHN S. MILLER, ESQ., ON MAINTENANCE AND REPAIR OF CHICAGO STREETS.

Committee of Nine on Chicago's Improvement,
Commercial Club, Chicago.

DEAR SIRS:—In response to your request for my opinion upon the questions hereinafter mentioned, which are suggested in the report of your consulting engineer, Mr. John W. Alvord, I beg to say:

1. *As to the question of providing for the expense of the maintenance and repair of streets by special assessments.*

Under the present constitution, the General Assembly cannot vest the corporate authorities of cities with power to levy special assessments, except for the purpose of making local improvements; and the Supreme Court of Illinois has held that the maintenance or repair of streets is not a "local improvement," within the meaning of the constitutional provision, and that special assessments cannot be levied for that purpose.

2. *As to providing a fund for maintenance and repair of streets by means of some tax or excise from those using them, such as a wheelage tax or license fee.*

This cannot be done under the provisions of the present city charter, except by license ordinance applicable to those whose vehicles are used or carry for hire. Such an ordinance could not be made to apply to owners of private vehicles used in their own business or for their own pleasure. With the consideration I have given the subject, I am not able to give an opinion that this could be effectively accomplished under a new or amended charter, within the provisions of the present Constitution. I do not think that question has been definitely decided; but while there is ground in decisions of the courts for maintaining the affirmative, viz., that such a contribution for using improved streets may be exacted, the decision of the Supreme Court in the late bicycle "Wheel tax case" indicates that such a scheme, if made to apply to vehicles not used for hire, would not be upheld. I think it possible, however, that a plan of this kind — if reasonably just and fair, and confined to an exaction for, or for carrying on a business requiring the greater use of improved streets, which mainly makes their improvement necessary and causes their wear,— might if authorized by charter, be sustained as valid.

3. *It is within the power of the City Council to determine how the fund available for maintenance, repair, or cleaning the streets shall be distributed and used, so as best to meet the public necessity or convenience.*

Such an appropriation from the general fund is the only method open to

the City Council under existing laws. The general fund is now inadequate. It can only be increased by increasing the amount extended upon the tax-books for the city tax; and that cannot be looked for with any certainty under the present law, which prescribes a maximum aggregate amount of taxes of five per cent of the assessed value of the property against which such taxes are extended, and provides for a uniform or pro rata reduction of all the tax levies (exclusive of those for certain specified taxes which are excepted from such reduction) certified by the different taxing bodies, in order to bring the aggregate down to that limit, when, as now occurs, the aggregate of such tax levies as so certified exceeds the limit.

Very truly yours,

JOHN S. MILLER.

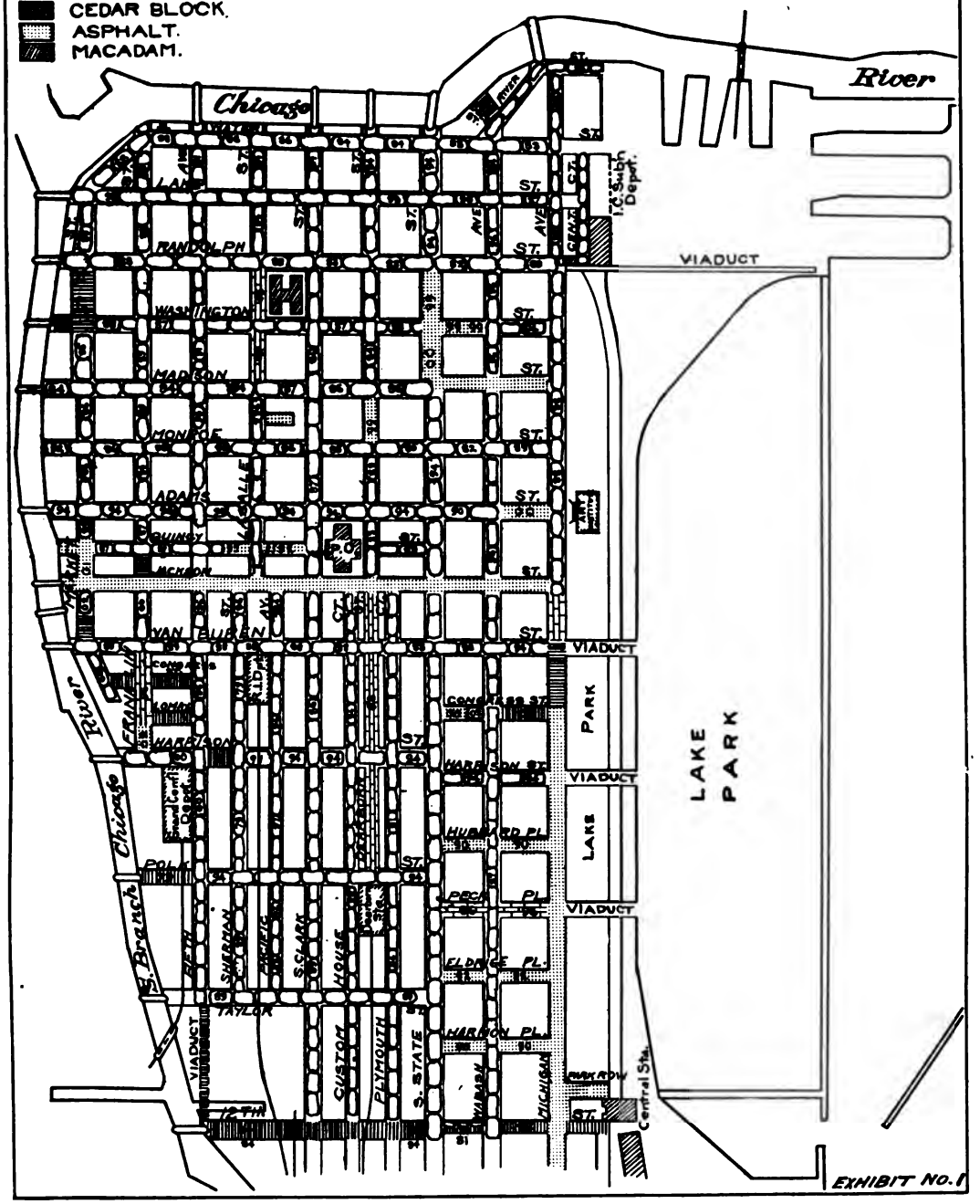
INDEX TO EXHIBITS.

TO ACCOMPANY REPORT OF J.W. ALVORD.

MAP OF BUSINESS DISTRICT OF CHICAGO SHOWING STREET PAVEMENTS. 1903.

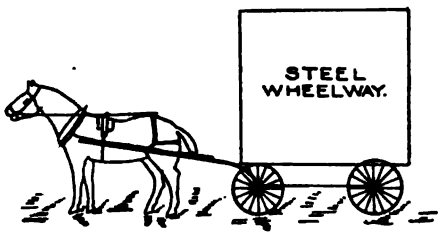
FIGURES DENOTE YEAR WHEN LAID.

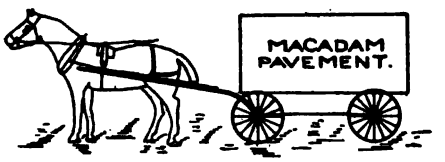
STONE.
BRICK.
CEDAR BLOCK.
ASPHALT.
MACADAM.

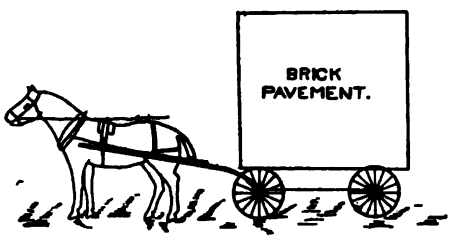


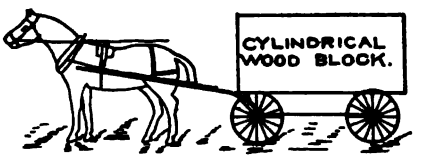
EXHIBIT

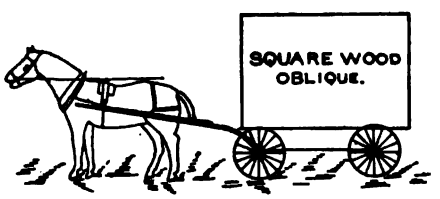
COMPARATIVE SIZE OF LOAD
WHICH CAN BE DRAWN ON
VARIOUS KINDS OF ROAD SURFACES
IN AVERAGE CONDITION WITH
EQUAL EXPENDURE OF FORCE.

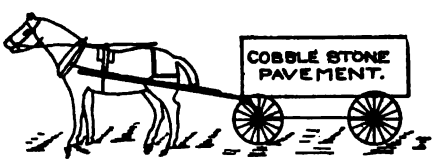


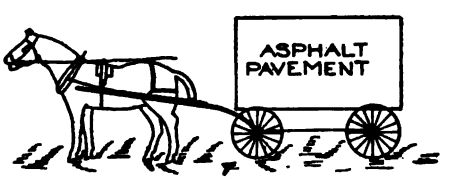


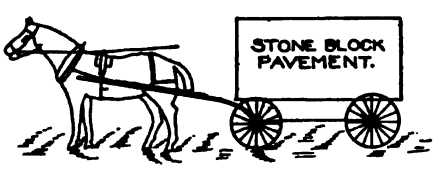












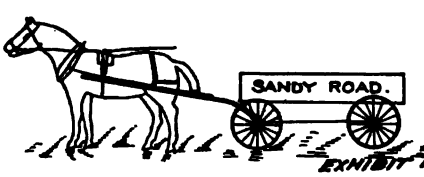
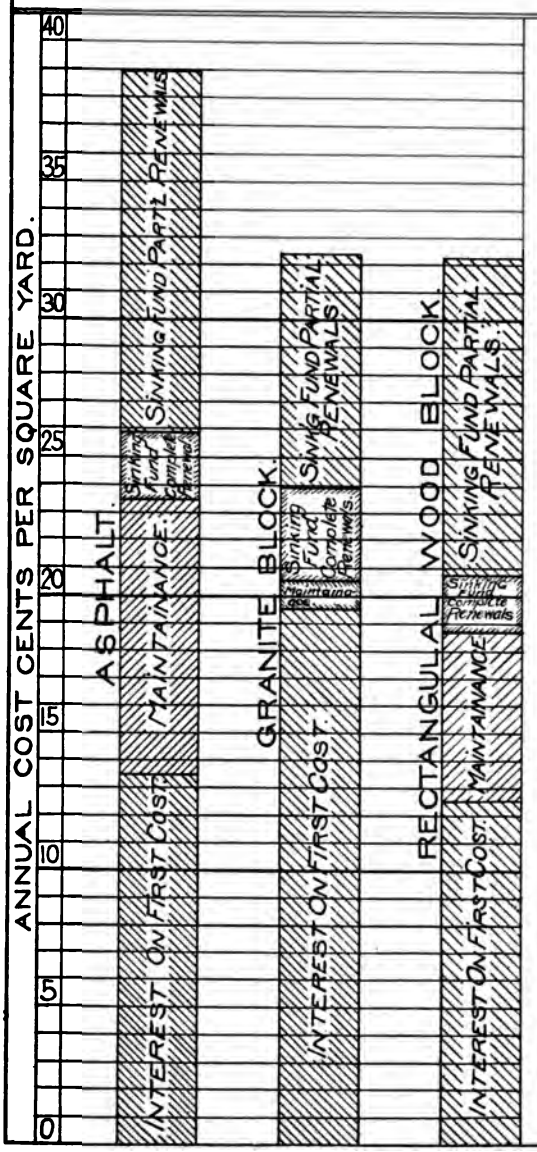


EXHIBIT NO. 3

TO ACCOMPANY REPORT OF J.W. ALVORD

COMPARATIVE ANNUAL COST.

PAVEMENTS FOR CHICAGO BUSINESS STREETS.



ASPHALT.

ASPHALT $2.70, 3 RENEWALS	
INT. 1ST. COST @5%	.135
ANNUAL MAINTAINANCE	.10
ANNUAL S.F. Complete Renewal $2.70, 3%, 50 YRS.	.024
ANNUAL S.F. Partial Renewal $1.80, 3%, 12½ YRS.	.121
	.380

GRANITE BLOCK

GRANITE $3.90, Renewal	
INT. 1ST. COST @ 5%	.195
ANNUAL MAINTAINANCE	.01
ANNUAL S.F. Complete Renewal $3.90, 3%, 50 YRS.	.0346
ANNUAL S.F. Partial Renewal 3.00, 3%, 25 YRS.	.082
	.3216

RECTANGULAR WOOD BLOCK.

SQ. WOOD BLOCK (CREOSOTED)	
$2.50 3 Renewals. INT. 1ST. COST@5%	.125
ANNUAL MAINTAINANC	.06
ANNUAL S.F. Complete Renewa $2.50, 3%, 50 YRS	.022
ANNUAL S.F. Partial Renewal $1.70, 3%, 12½ YRS.	.114
	.321

EXHIBIT NO. 4

TO ACCOMPANY REPORT OF J.W. ALVORD.

SUGGESTION FOR
RESIDENCE STREET INTERSECTION
IN LOCALITY OF LIGHT TRAFFIC.

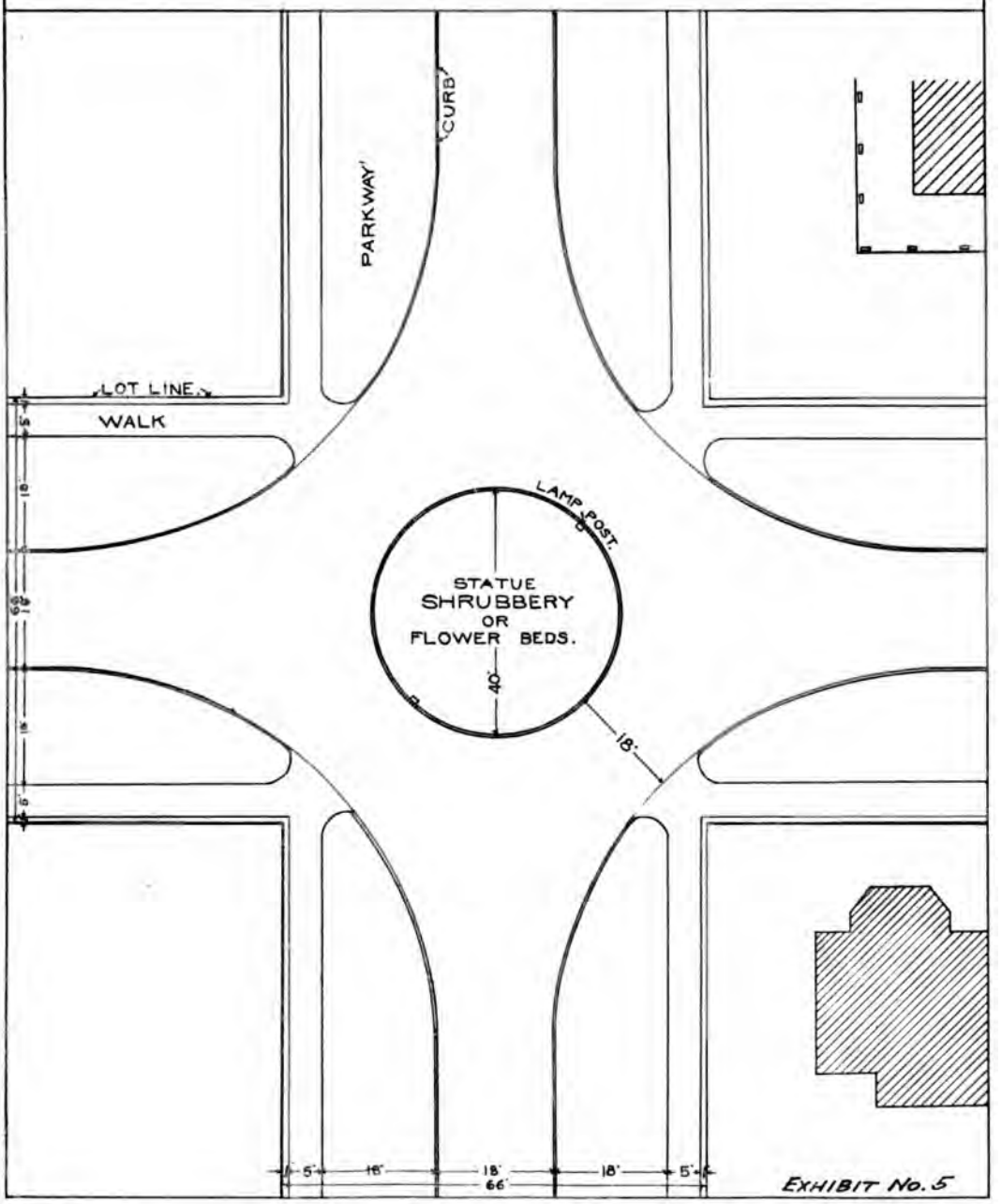


EXHIBIT No. 5

TO ACCOMPANY REPORT OF J.W. ALVORD.

A SUGGESTION
FOR
BEAUTIFYING RESIDENCE STREETS
BY
SODDING BETWEEN CAR TRACKS.

66 FT. ROAD.

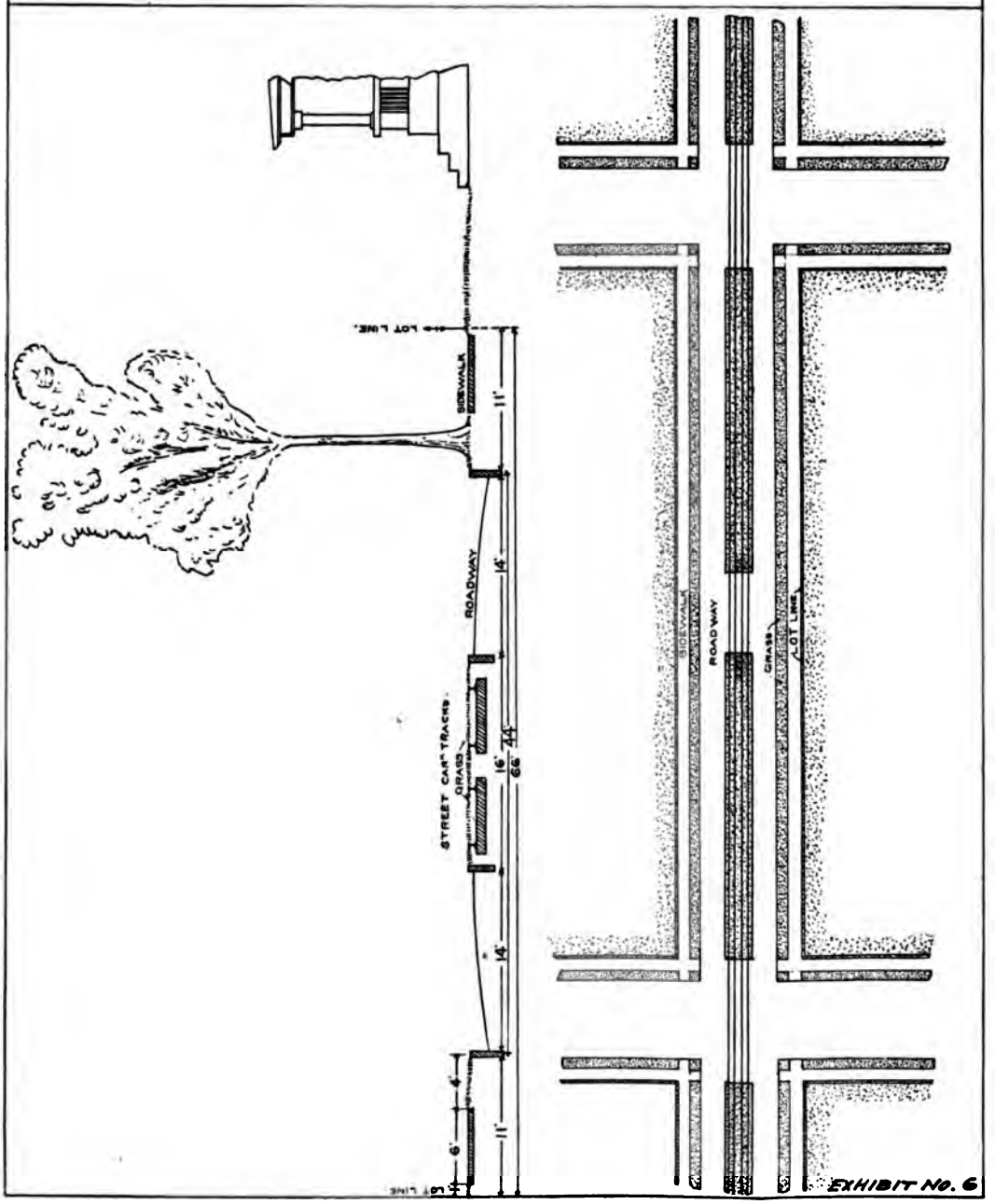


EXHIBIT No. 6

TO ACCOMPANY REPORT OF J.W. ALVORD.

A SUGGESTION
FOR
BEAUTIFYING RESIDENCE STREETS
BY
SODDING BETWEEN CAR TRACKS.
80 FT. ROAD.

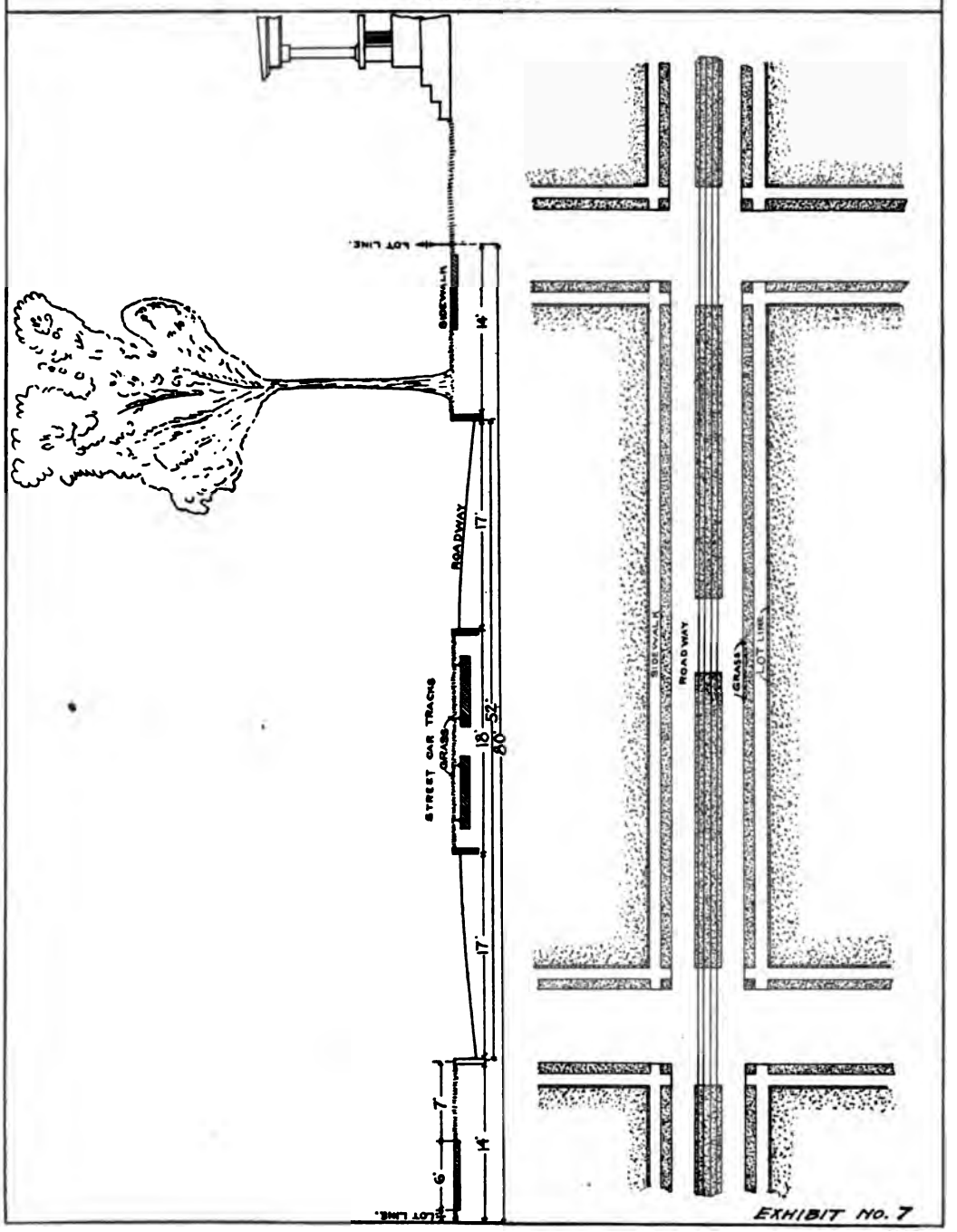
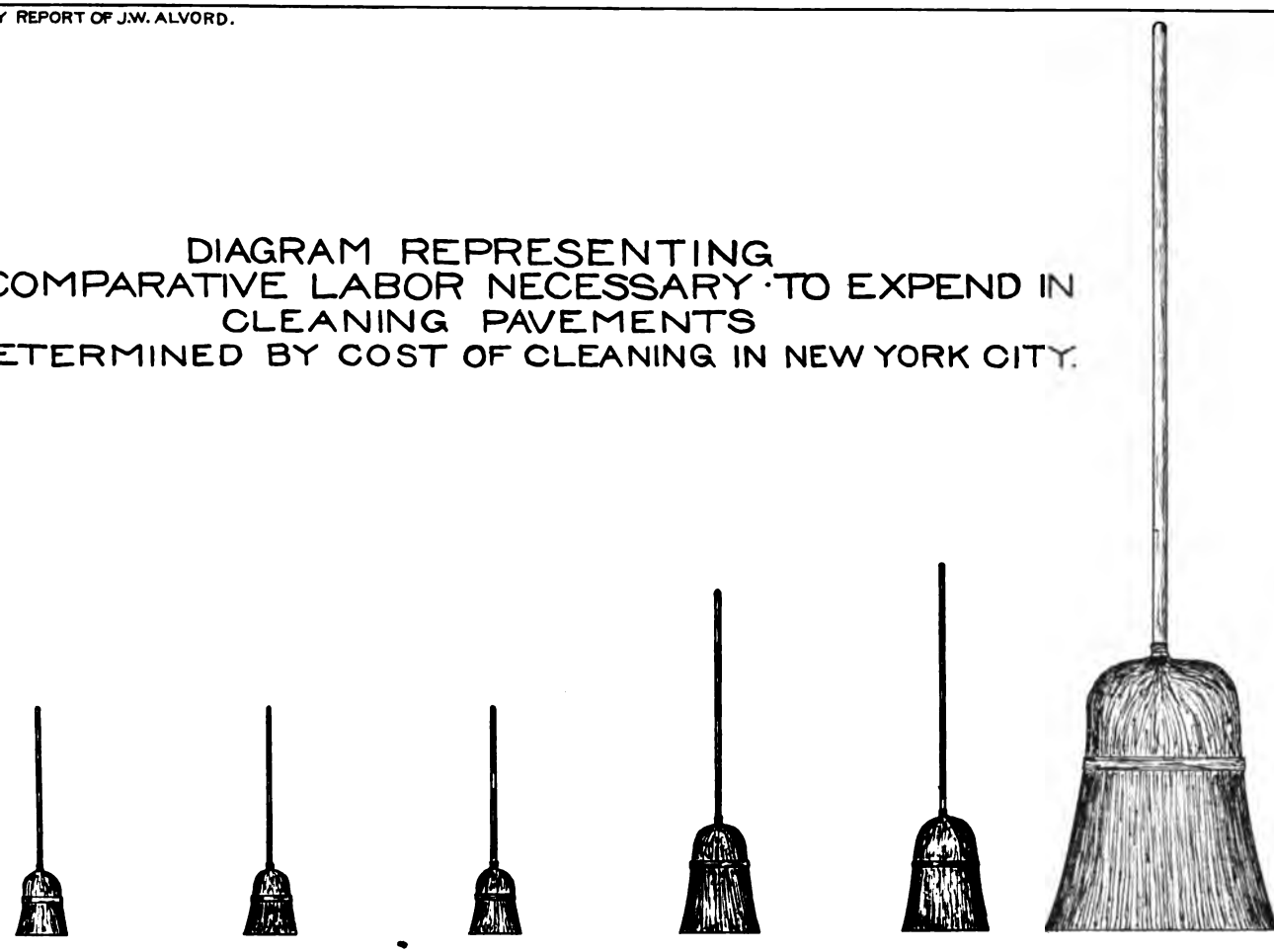


EXHIBIT NO. 7

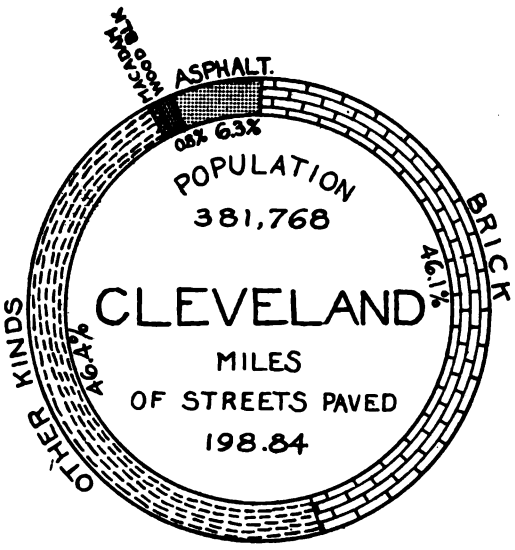
TO ACCOMPANY REPORT OF J.W. ALVORD.

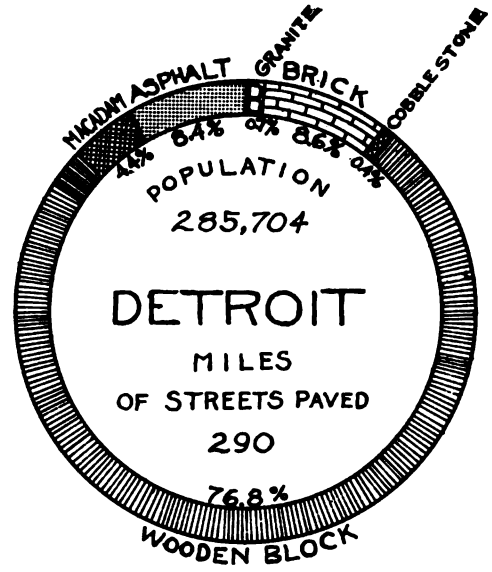
DIAGRAM REPRESENTING THE COMPARATIVE LABOR NECESSARY TO EXPEND IN CLEANING PAVEMENTS AS DETERMINED BY COST OF CLEANING IN NEW YORK CITY.



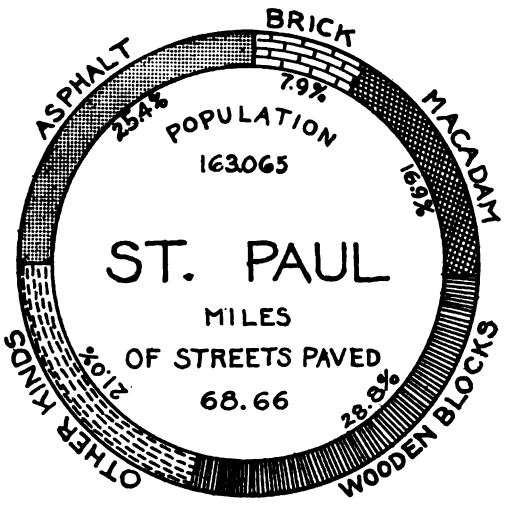
ASPHALT.	BRICK.	RECTANGULAR WOOD BLOCK.	GRANITE BLOCK.	BELGIAN BLOCK.	COBBLESTONE.
100	100	100	150	160	400

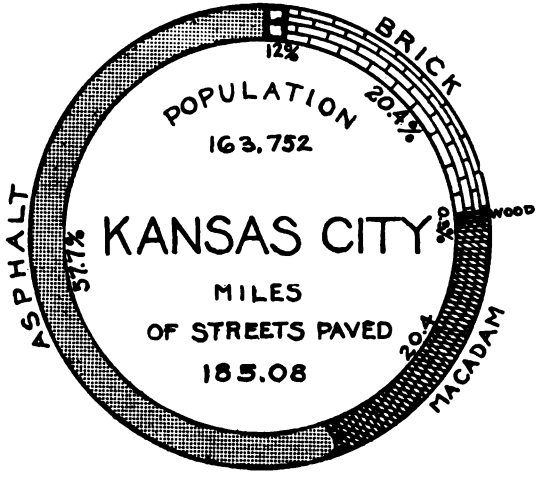
EXHIBIT No. 8


MACADAM
WOOD BLK
ASPHALT
0.8%
6.3%
POPULATION
381,768
CLEVELAND
MILES
OF STREETS PAVED
198.84
BRICK
46.1%
OTHER KINDS
46.4%


MACADM
ASPHALT
GRANITE
BRICK
COBBLE STONE
4.4%
8.4%
0.7%
8.6%
0.4%
POPULATION
285,704
DETROIT
MILES
OF STREETS PAVED
290
76.8%
WOODEN BLOCK


BRICK
ASPHALT
GRANITE
WOODEN BLOCKS
1%
5.5%
2.7%
15.4%
POPULATION
297,500
MILWAUKEE
MILES
OF STREETS PAVED
315.27
75.4%
MACADAM


BRICK
ASPHALT
7.9%
25.4%
POPULATION
163,065
MACADAM
16.9%
ST. PAUL
MILES
OF STREETS PAVED
68.66
OTHER KINDS
21.0%
28.8%
WOODEN BLOCKS


12%
BRICK
POPULATION
163,752
20.4%
ASPHALT
57.7%
KANSAS CITY
0.5%
WOOD
MILES
OF STREETS PAVED
185.08
20.4
MACADAM

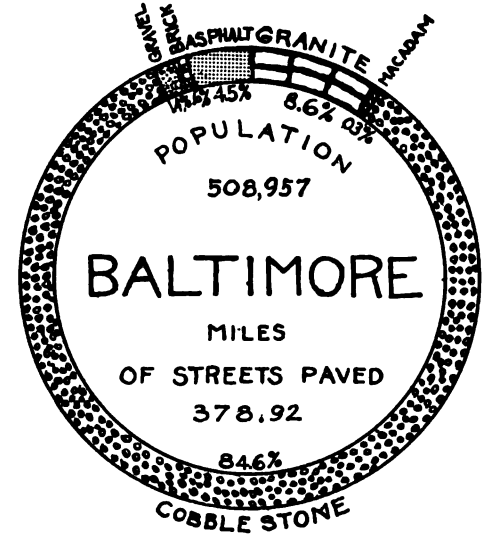
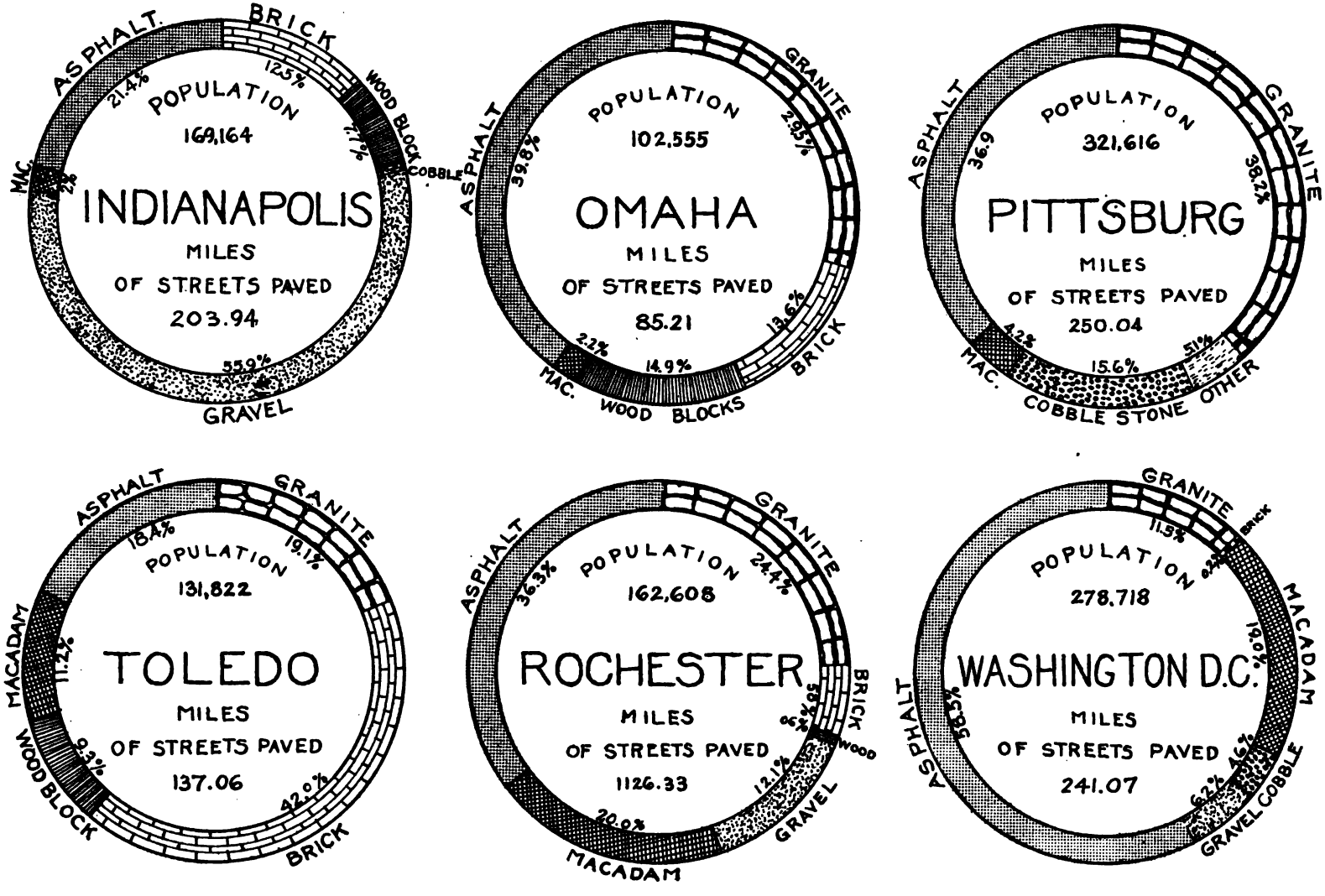

GRAVEL
BRICK
ASPHALT
GRANITE
MACADAM
4.5%
8.6%
0.3%
POPULATION
508,957
BALTIMORE
MILES
OF STREETS PAVED
378.92
84.6%
COBBLE STONE

EXHIBIT No. 9



EMILBERT No. 0

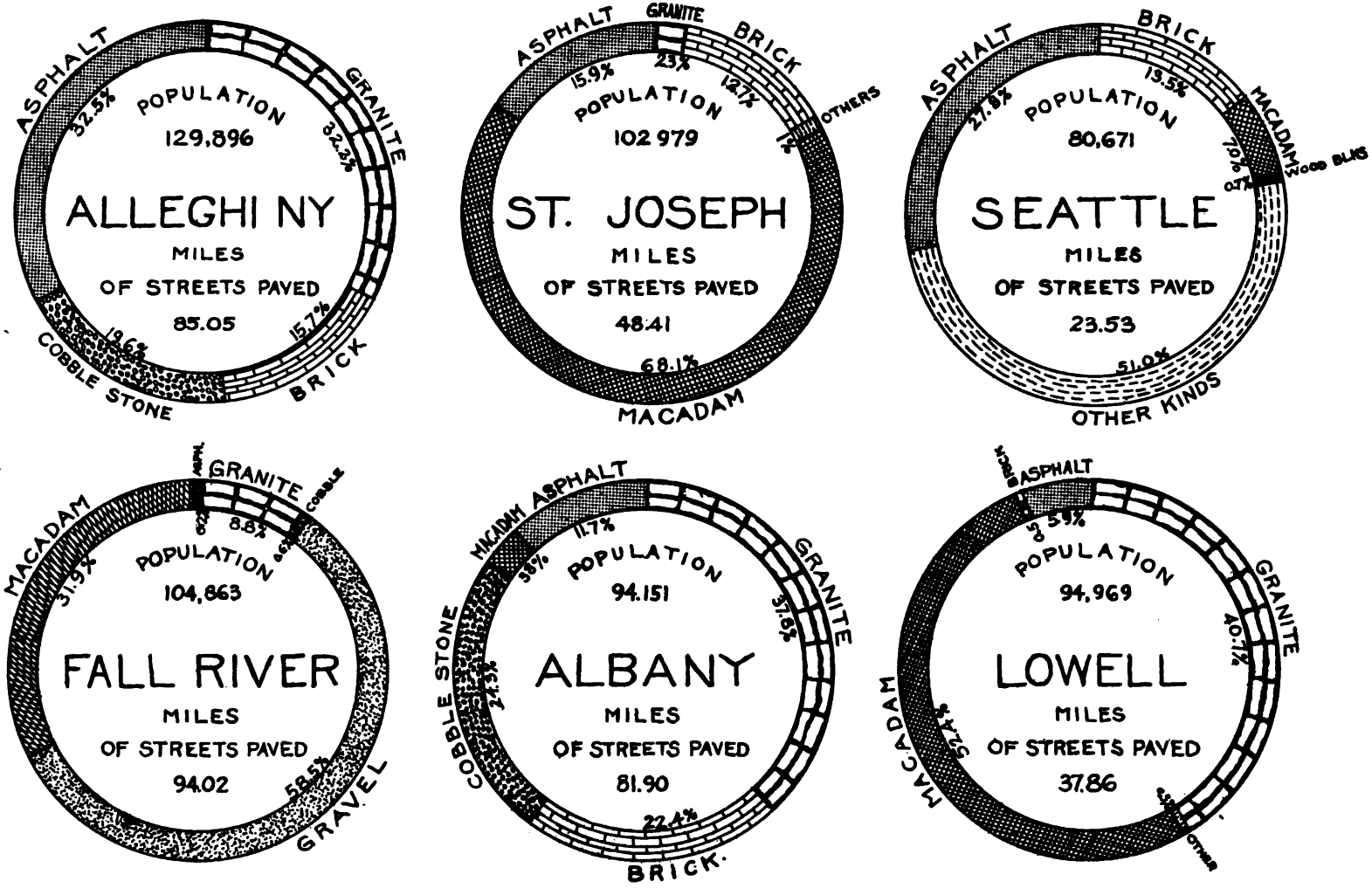
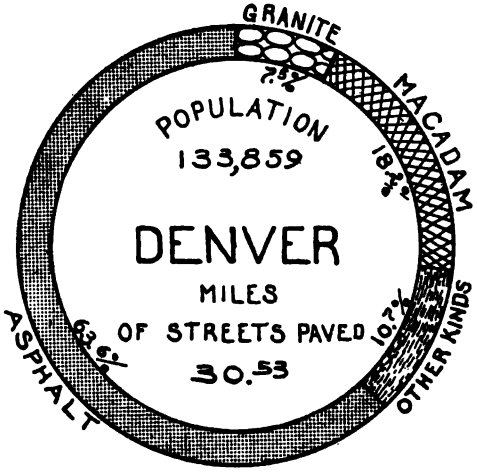
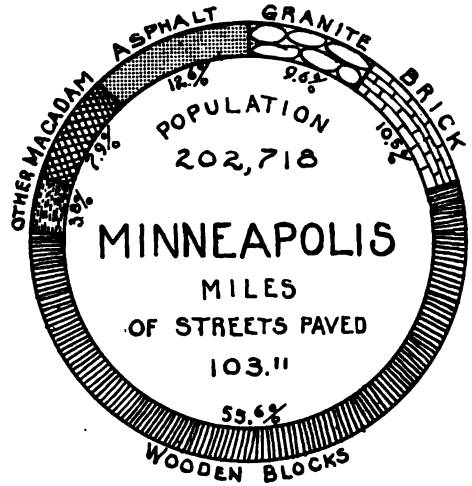


EXHIBIT No. 11.





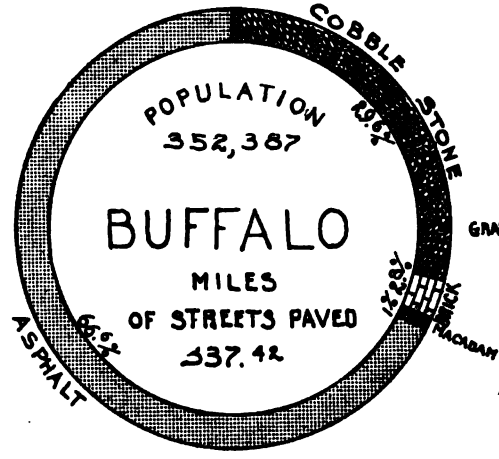
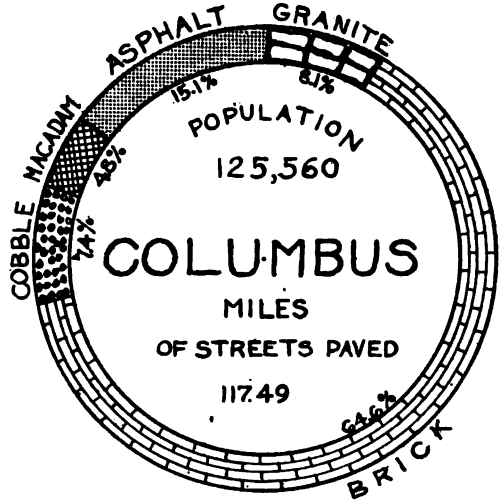
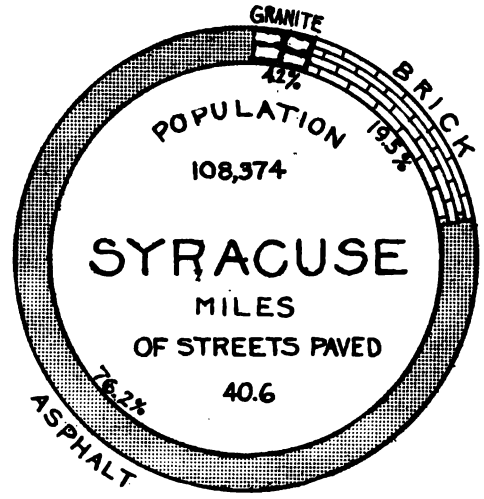
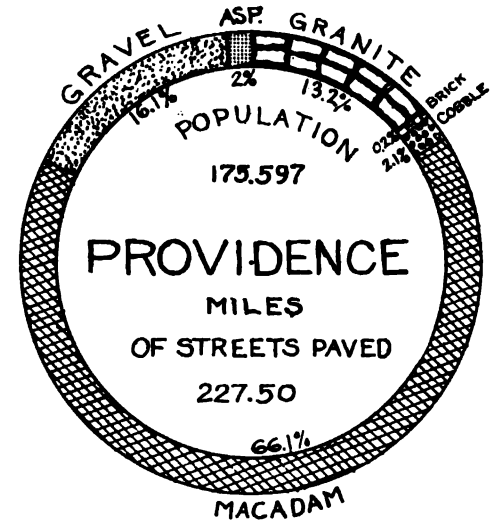
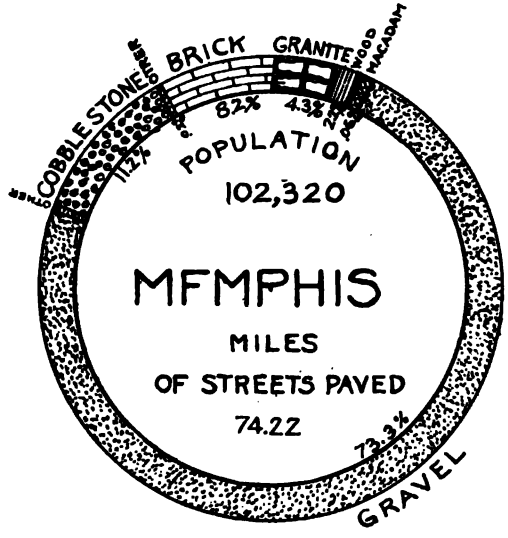


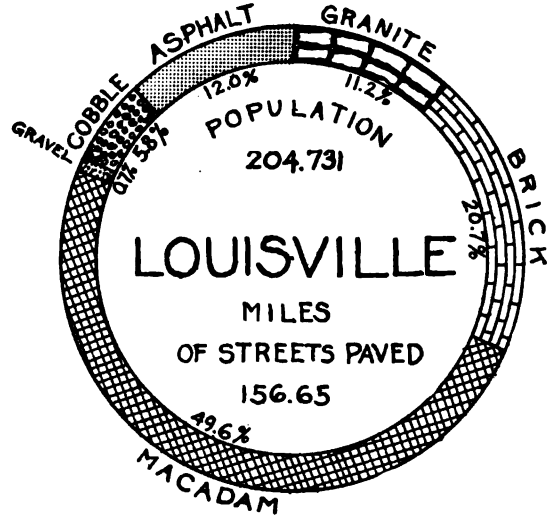
EXHIBIT No. 12.

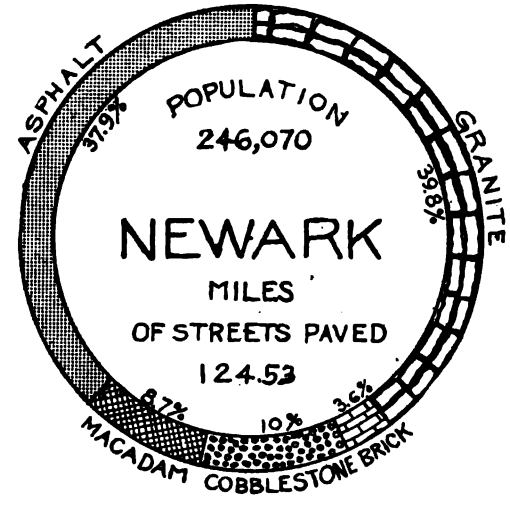












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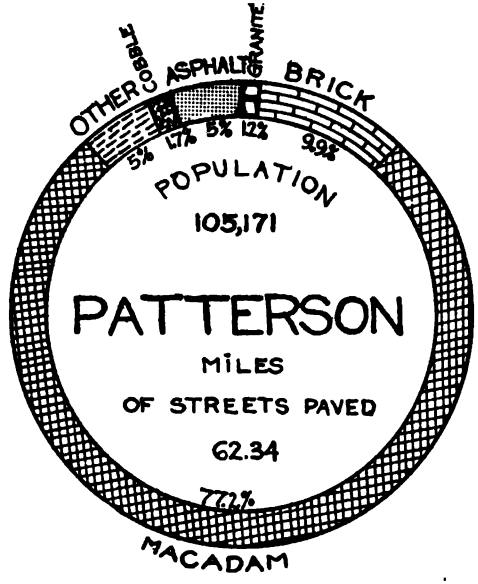
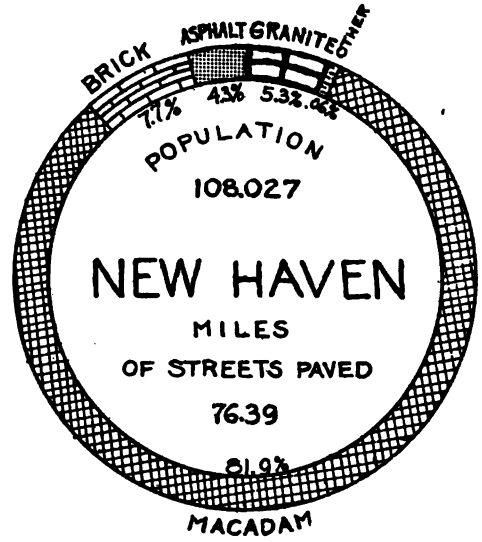
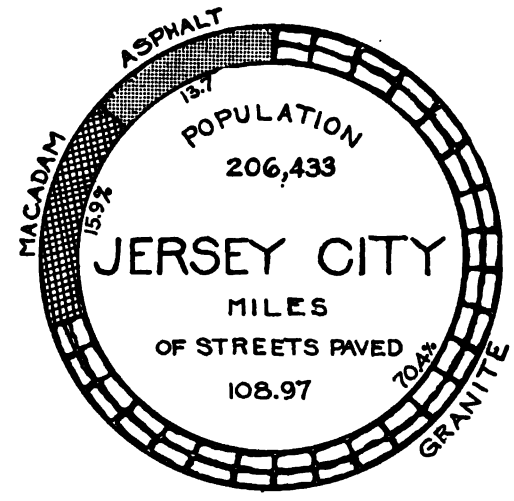
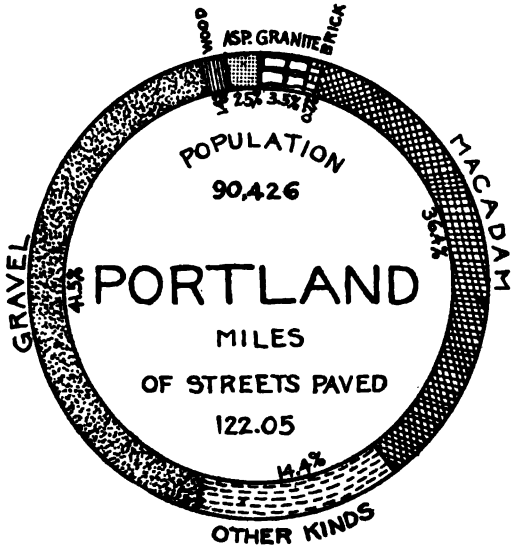
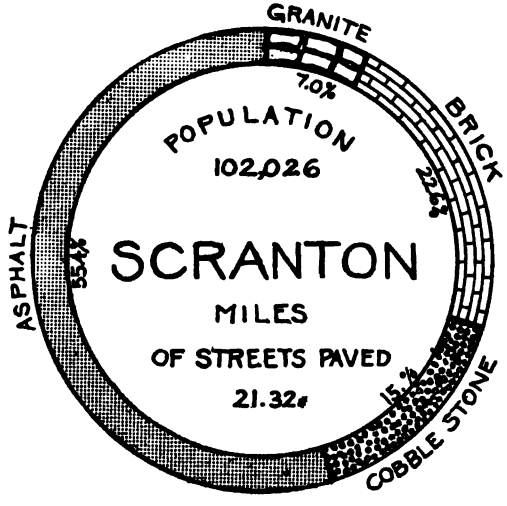










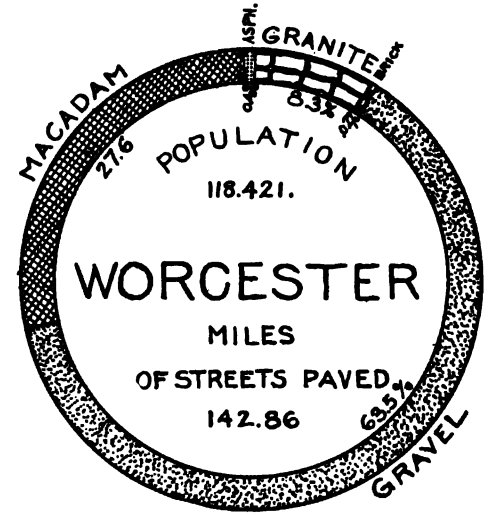


EXHIBIT No. 14.

TO ACCOMPANY REPORT OF J.W. ALVORD.

DIAGRAM SHOWING
PAVING TENDENCY IN 135 AMERICAN CITIES.
1890 TO 1901.

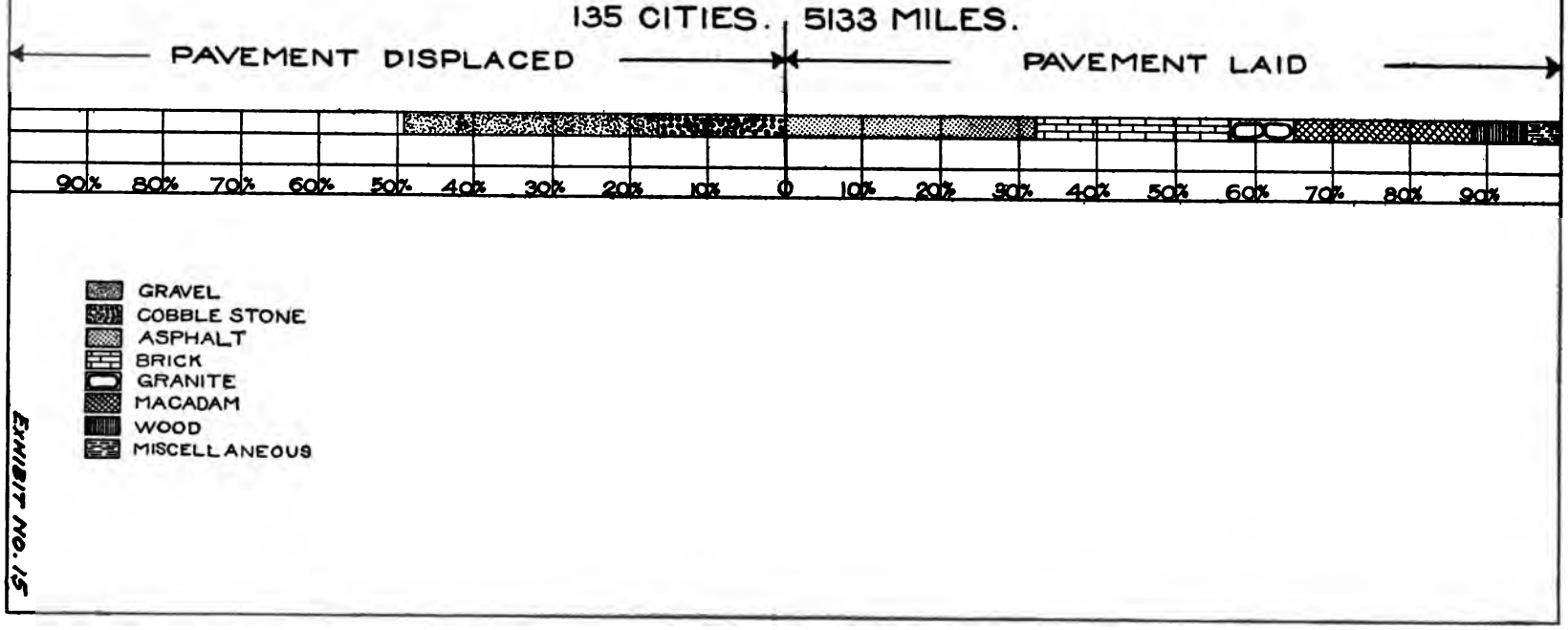
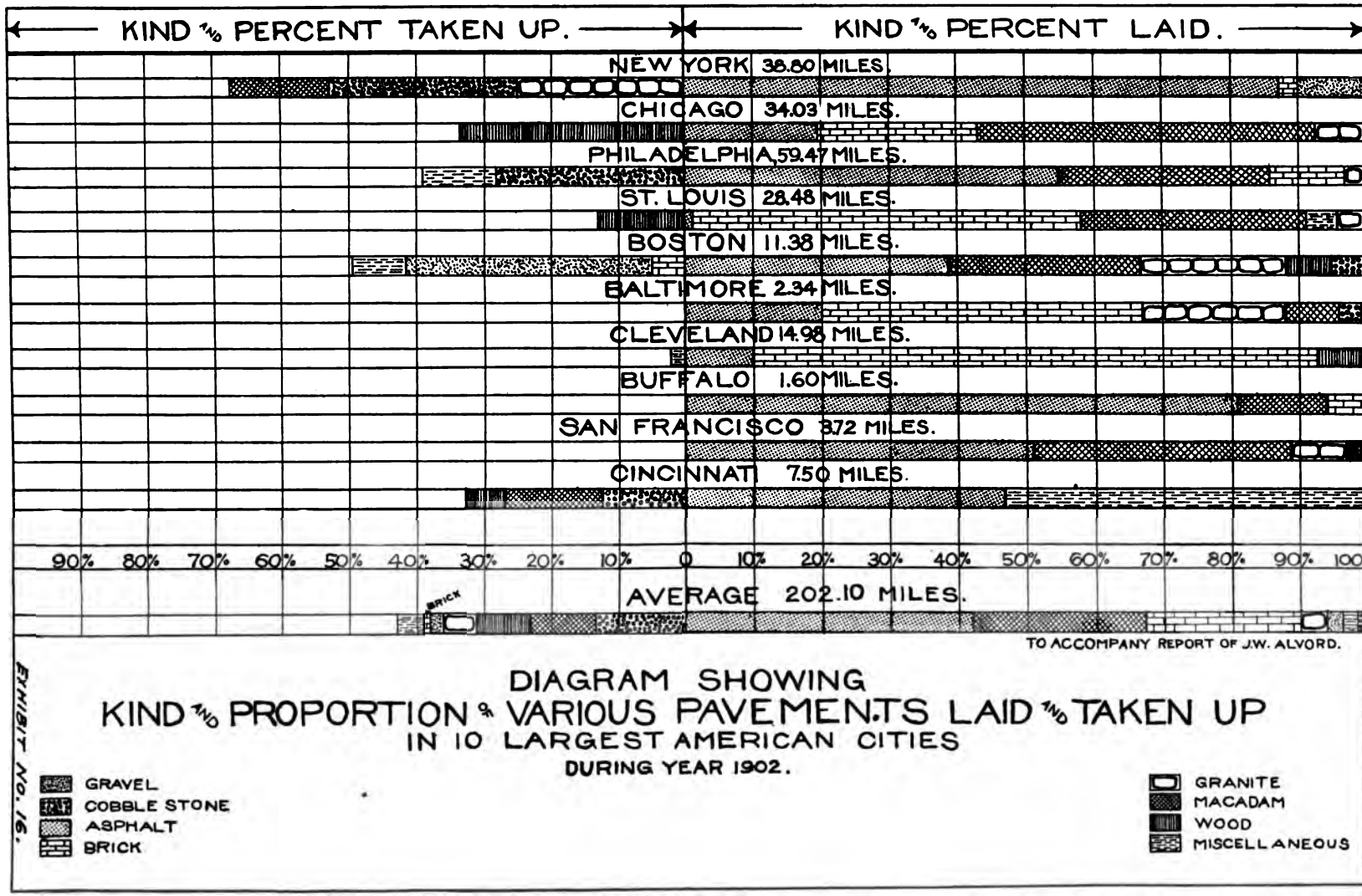
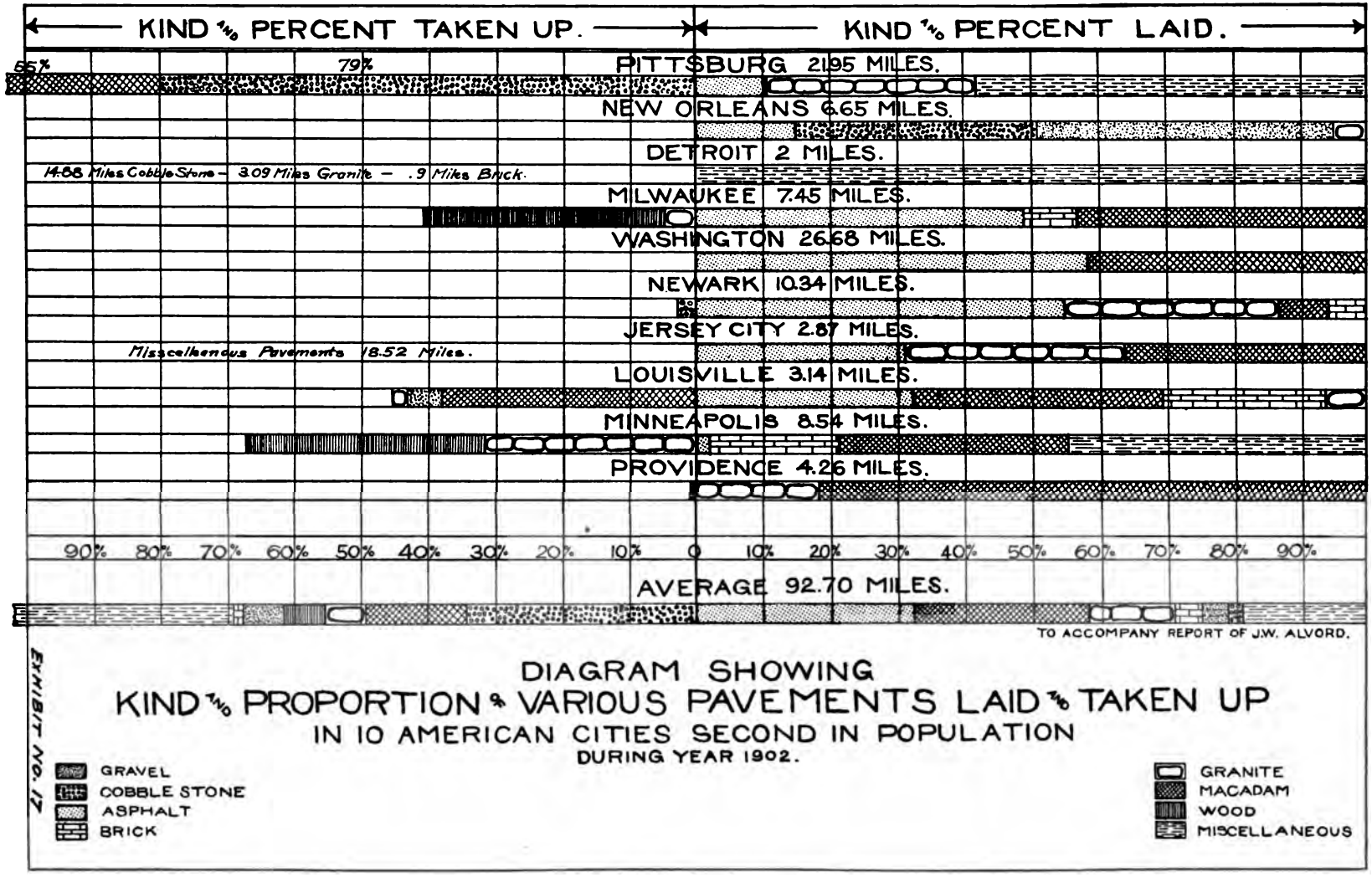


EXHIBIT NO. 15


KIND AND PERCENT TAKEN UP.
KIND AND PERCENT LAID.
NEW YORK 38.80 MILES.
CHICAGO 34.03 MILES.
PHILADELPHIA 59.47 MILES.
ST. LOUIS 28.48 MILES.
BOSTON 11.38 MILES.
BALTIMORE 2.34 MILES.
CLEVELAND 14.98 MILES.
BUFFALO 1.60 MILES.
SAN FRANCISCO 3.72 MILES.
CINCINNATI 7.50 MILES.
90% 80% 70% 60% 50% 40% 30% 20% 10% 0 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
AVERAGE 202.10 MILES.
BRICK
TO ACCOMPANY REPORT OF J.W. ALVORD.
DIAGRAM SHOWING
KIND AND PROPORTION OF VARIOUS PAVEMENTS LAID AND TAKEN UP
IN 10 LARGEST AMERICAN CITIES
DURING YEAR 1902.
GRAVEL
COBBLE STONE
ASPHALT
BRICK
GRANITE
MACADAM
WOOD
MISCELLANEOUS
EXHIBIT NO. 16.



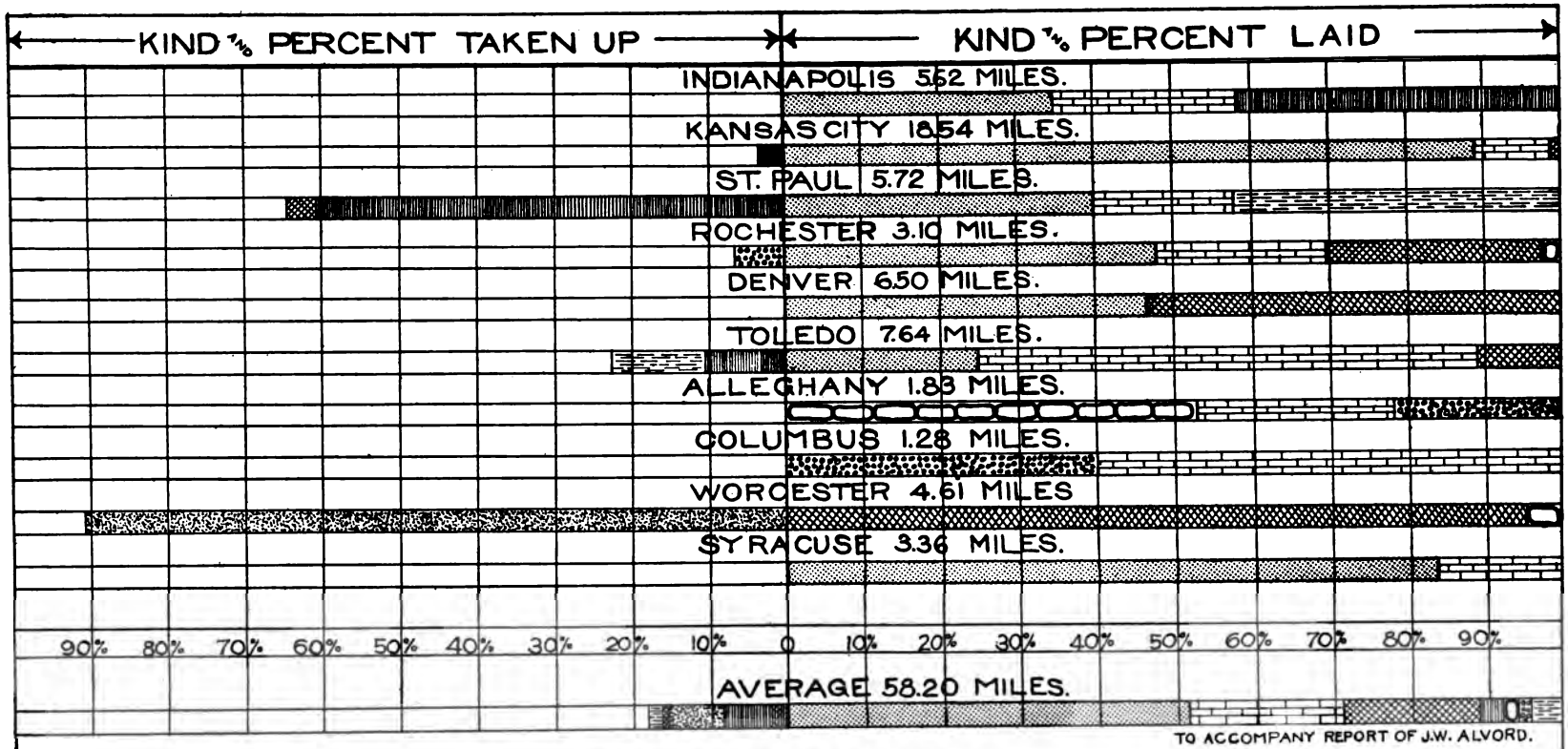
TO ACCOMPANY REPORT OF J.W. ALVORD.

EXHIBIT NO. 17

DIAGRAM SHOWING
KIND % PROPORTION & VARIOUS PAVEMENTS LAID % TAKEN UP
IN 10 AMERICAN CITIES SECOND IN POPULATION
DURING YEAR 1902.

GRAVEL
COBBLE STONE
ASPHALT
BRICK

GRANITE
MACADAM
WOOD
MISCELLANEOUS



TO ACCOMPANY REPORT OF J.W. ALVORD.

EXHIBIT No. 18.

DIAGRAM SHOWING KIND AND PROPORTION OF VARIOUS PAVEMENTS LAID AND TAKEN UP IN 10 AMERICAN CITIES THIRD IN POPULATION DURING YEAR 1902.

GRAVEL
COBBLE STONE
ASPHALT
BRICK

GRANITE
MACADAM
WOOD
MISCELLANEOUS

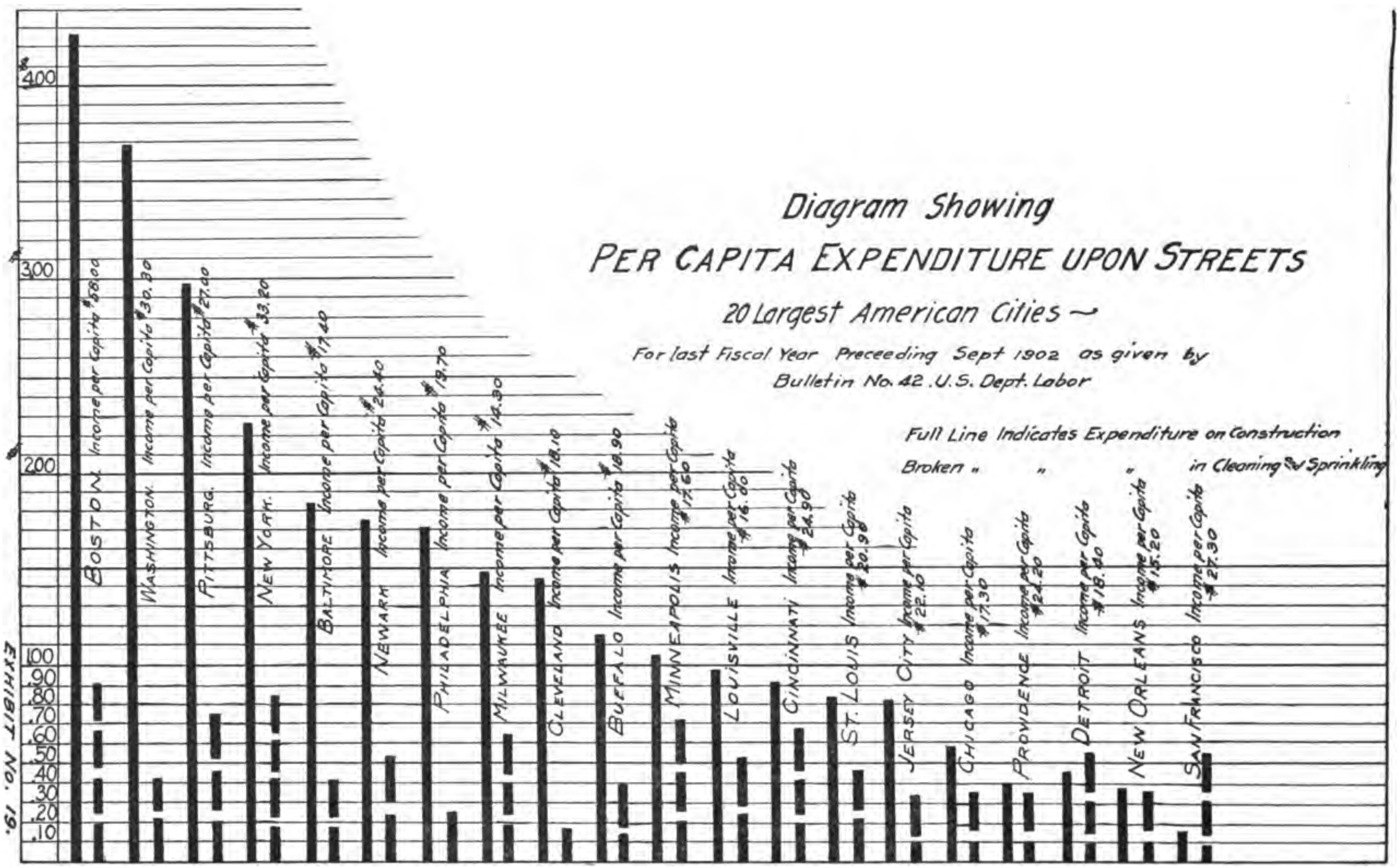


EXHIBIT No. 19.

PERCENTAGE OF VEHICLES USING CAR TRACKS.

CAR TRACK ON			WIDTH OF ROADWAY	TIME	DATE 1903	No. OF VEHICLES	USING TRACK	REMARKS
STREET	FROM	TO						
W. 12TH	BLUE ISLAND AV	HALSTED	40	7.00 7.20	10/2	35	60%	MANY CARS
"	"	CANAL	40	5.00 5.15	10/3	30	50%	" "
"	HALSTED	FRANKLIN	40	8.55 9.10	10/3	60	63%	" "
CANAL	W. 12TH	POLK	52	7.25 7.35	10/2	35	40%	
STATE	VAN BUREN	MADISON	60	9.15 9.30	10/2	126	33%	
"	E. 12TH	"	60	11.45 12.00	10/3	124	22%	
"	TAYLOR	E. 13TH	60	10.55 11.35	10/3	323	29%	TO DEPOTS
CLARK	VAN BUREN	MADISON	38	10.10 10.20	10/2	66	68%	
FRANKLIN	MADISON	ADAMS	48	2.05 2.15	10/2	25	80%	
ADAMS	HALSTED	MARKET	38	4.40 4.50	10/2	30	66%	
"	CLINTON	STATE	38	9.15 9.25	10/5	77	66%	
HALSTED	ADAMS	HARRISON	38	4.50 5.00	10/2	42	62%	
"	VAN BUREN	"	38	7.00 7.10	10/3	30	33%	MANY CARS
"	"	TAYLOR	38	8.25 8.40	10/3	140	60%	
"	"	W. 12TH	38	10.00 11.30	10/4	40	30%	SUNDAY
"	RANDOLPH	VAN BUREN	38	" "	"	35	40%	"
"	GRAND AV.	RANDOLPH	38	"	"	23	30%	"
MILWAUKEE AV	CHICAGO AV.	GRAND AV	38	"	"	28	40%	"
BLUE ISLAND	HARRISON ST.	W. 12TH ST.	48	6.45 7.00	10/3	32	72%	
"	"	"	48	7.00 7.10	10/6	46	60%	
CLINTON ST.	WASHINGTON	HARRISON ST.	48	9.00 9.15	10/5	61	55%	
MADISON ST	HALSTED ST.	STATE ST.	48	10.00 10.20	10/5	96	60%	
LAKE ST.	"	"	48	2.30 2.40	10/5	144	66%	
N. OF HARRISON	"	CHICAGO RIVER	MISC.	8.00 5.00	10/6	130	58%	
"	CENTER AV.	HALSTED ST	"	"	10/7	400	62%	
N. OF RANDOLPH	ASHLAND AV	CENTRE AV.	"	"	10/8	400	70%	
N. OF TAYLOR	HALSTED	CHICAGO RIVER	"	"	10/9	330	40%	
S. OF 63RD ST	ENGLEWOOD	So. CHICAGO	"	"	10/10	325	63%	
S. OF 87TH ST	WESTERN AV.	HALSTED ST	"	"	10/12	250	70%	
S. OF 63RD ST	HALSTED ST	COTTAGE GROVE	"	"	10/13	300	52%	
S. OF 71ST ST	COTTAGE GR.	STONY ISLAND	"	"	10/14	288	70%	
N. OF HARRISON	HALSTED ST	STATE ST.	"	"	10/20	72	70%	
"	"	"	"	"	10/21	100	50%	
"	"	"	"	"	10/22	93	57%	

EXHIBIT No. 20

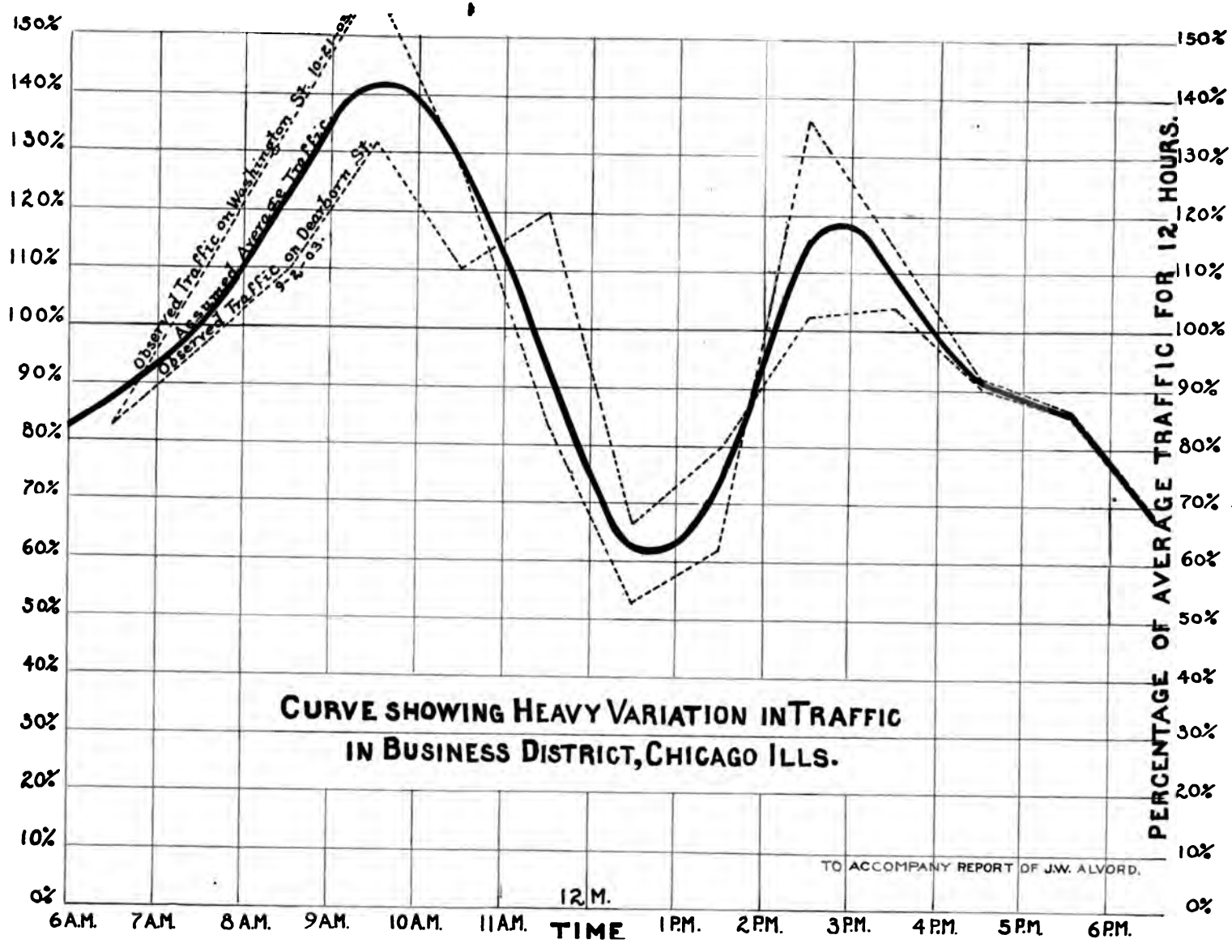
FOOT PASSENGERS PASSING IN ONE HOUR.

CROSSING OF		HOUR	NUMBER
STATE ST.	VAN BUREN	9.00 10.00	5280
ASHLAND AV.	W. 22ND	6.30 7.30	5100
HALSTED ST.	ARCHER AV.	6.30 7.30	3000
RANDOLPH ST.	5TH AV.	11.00 12.00	2760
HARRISON ST.	PLYMOUTH PL.	11.00 12.00	2460
"	HALSTED ST.	2.00 3.00	2160
"	CANAL ST.	2.00 3.00	408
"	5TH. AV.	4.00 5.00	1152
MADISON ST.	FRANKLIN ST.	2.00 3.00	3360
VAN BUREN ST.	LA SALLE ST.	11.00 12.00	3900
ADAMS ST.	FRANKLIN ST.	3.00 4.00	3240
"	MARKET ST.	4.00 5.00	2280
VAN BUREN ST.	HALSTED ST.	8.00 9.00	2160
E. 12TH ST.	5TH AV.	9.00 10.00	720
"	STATE ST.	11.00 12.00	840
LAKE ST.	FRANKLIN ST.	2.00 3.00	1560
POLK ST.	5TH AV.	3.00 4.00	660
W. 12TH ST.	CANAL ST.	4.00 5.00	720
HALSTED ST.	POLK ST.	8.00 9.00	840
DESPLAINES ST.	"	9.00 10.00	660
COSTUMHOUSE PL.	"	11.00 12.00	1920
LAKE ST.	CANAL ST.	2.00 3.00	2040
MADISON ST.	CLINTON ST.	4.00 5.00	1800
VAN BUREN ST.	"	8.00 9.00	1800
HARRISON ST.	CENTRE AV.	8.00 9.00	420
ADAMS ST.	"	9.00 10.00	240
MADISON ST.	MORGAN ST.	10.00 11.00	480
CONGRESS ST.	PEORIA ST.	11.00 12.00	360
MADISON ST.	"	1.00 2.00	840
RANDOLPH ST.	"	2.00 3.00	720
"	OGDEN AV.	3.00 4.00	300
ASHLAND AV.	GRAND AV.	3.30 4.30	540
"	CHICAGO AV.	4.00 5.00	960
MILWAUKEE	"	4.00 5.00	1320
CONGRESS ST.	DES PLAINES	8.00 9.00	240
ADAMS ST.	CLINTON ST.	9.00 10.00	1680
E. 16TH ST.	MICHIGAN BLV.	10.00 11.00	480
E. 22ND ST.	COTTAGE GROVE	1.00 2.00	1080
"	So. 40TH AV.	10.00 11.00	600
KEDZIE AV.	MILWAUKEE AV.	7.00 8.00	480
"	CHICAGO AV.	8.00 9.00	300

CROSSING OF		OCT. 1903 HOUR	NUMBER
STATE ST.	ARCHER AV.	1.00 2.00	1680
39TH ST.	INDIANA AV.	2.00 3.00	720
31ST. ST.	STATE ST.	3.30 4.30	1440
55TH. ST.	COTTAGE GROVE	7.00 8.00	480
63RD ST.	" "	8.00 9.00	1560
" "	MADISON AV.	9.00 10.00	600
92ND "	EWING AV.	10.00 11.00	360
" "	COMMERCIAL AV.	1.00 2.00	160
95TH ST.	EWING AV.	11.00 12.00	240
100TH ST.	"	11.30 12.30	480
COMMERCIAL AV.	BALTIMORE AV.	2.00 3.00	180
79TH ST.	STONY IS. AV.	3.00 4.00	240
75TH ST.	"	4.00 5.00	360
73RD ST.	VINCENNES AV.	7.00 8.00	480
68TH ST.	"	7.30 8.30	600
67TH ST.	STEWART AV.	8.30 9.30	240
65TH ST.	"	9.30 10.30	600
63RD ST.	HALSTED ST.	11.00 12.00	1560
69TH ST.	ASHLAND AV.	8.00 9.00	180
103RD ST.	VINCENNES AV.	10.00 11.00	360
107TH ST.	"	11.00 12.00	180
95TH ST.	COTTAGE GROVE	1.00 2.00	600
93RD ST.	"	2.00 3.00	240
87TH ST.	"	2.00 3.00	24
79TH ST.	"	3.00 4.00	12
75TH ST.	So. CHICAGO AV.	3.00 4.00	720
71ST ST.	WOODLAWN AV.	4.00 5.00	120
70TH ST.	MADISON AV.	4.00 5.00	240
67TH ST.	"	4.00 5.00	240
47TH ST.	ASHLAND AV.	7.00 8.00	1800
"	WESTERN AV.	8.00 9.00	600
38TH ST.	ARCHER AV.	9.00 10.00	600
35TH ST.	WESTERN AV.	10.00 11.00	240
"	HALSTED ST.	11.00 12.00	960
26TH ST.	WESTERN AV.	7.00 8.00	3600
W. 12TH ST.	OGDEN AV.	8.00 9.00	1800
"	KEDZIE AV.	9.00 10.00	480
"	So. 40TH AV.	10.00 11.00	480
ARMITAGE AV.	"	8.00 9.00	360
NORTH AV.	"	9.00 10.00	360
CHICAGO AV.	GRAND AV.	10.00 11.00	240

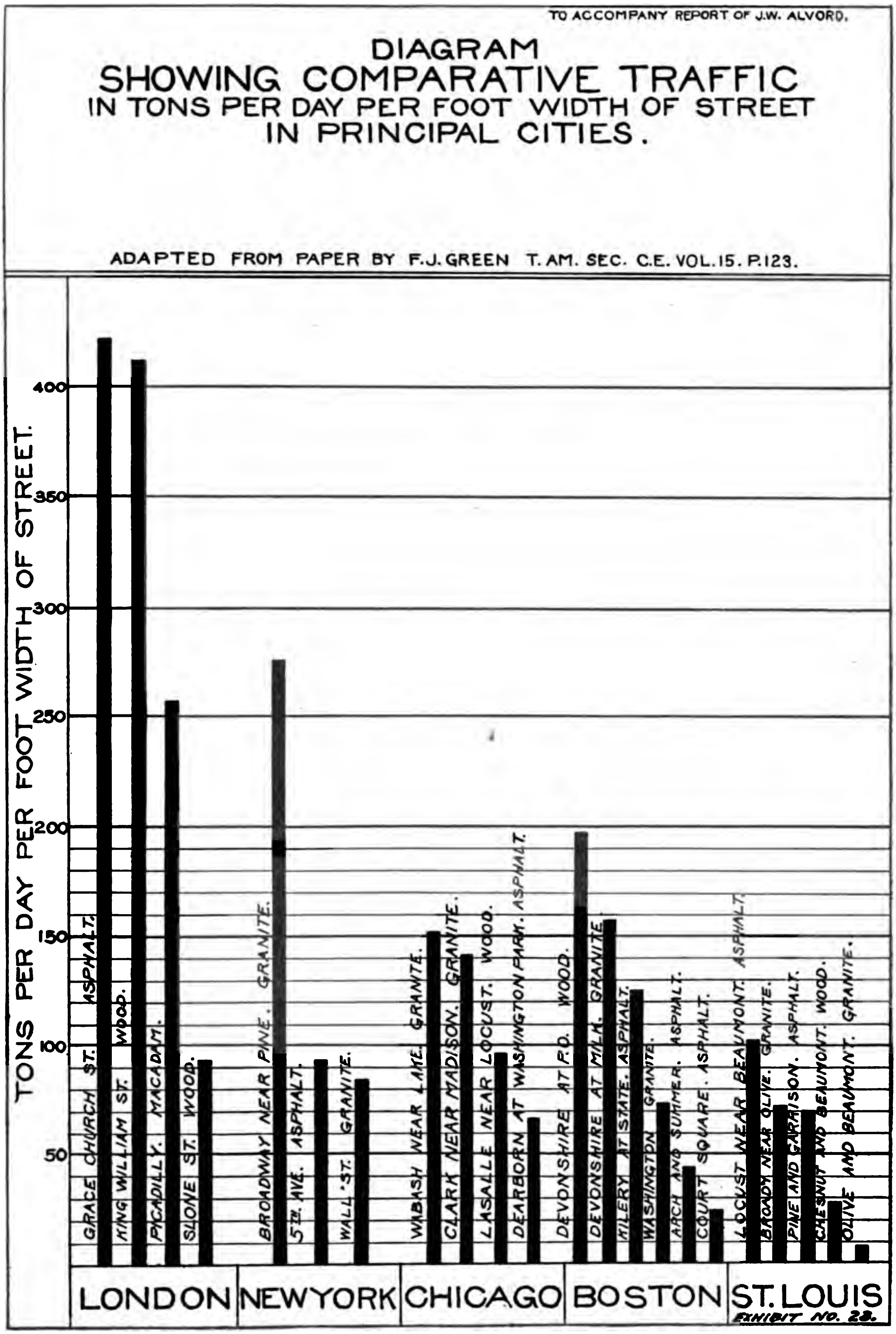
EXHIBIT NO. 21.

EXHIBIT No. 22.



CURVE SHOWING HEAVY VARIATION IN TRAFFIC IN BUSINESS DISTRICT, CHICAGO ILLS.

TO ACCOMPANY REPORT OF J.W. ALVORD.


TO ACCOMPANY REPORT OF J.W. ALVORD.
DIAGRAM
SHOWING COMPARATIVE TRAFFIC
IN TONS PER DAY PER FOOT WIDTH OF STREET
IN PRINCIPAL CITIES.
ADAPTED FROM PAPER BY F.J. GREEN T. AM. SEC. C.E. VOL. 15. P. 123.
TONS PER DAY PER FOOT WIDTH OF STREET.
400
350
300
250
200
150
100
50
GRACE CHURCH ST. ASPHALT.
KING WILLIAM ST. WOOD.
PICADILLY. MACADAM.
SLONE ST. WOOD.
BROADWAY NEAR PINE. GRANITE.
5TH AVE. ASPHALT.
WALL ST. GRANITE.
WABASH NEAR LAKE. GRANITE.
CLARK NEAR MADISON. GRANITE.
LASALLE NEAR LOCUST. WOOD.
DEARBORN AT WASHINGTON PARK. ASPHALT.
DEVONSHIRE AT P.O. WOOD.
DEVONSHIRE AT MILK. GRANITE.
KILBY AT STATE. ASPHALT.
WASHINGTON. GRANITE.
ARCH AND SUMMER. ASPHALT.
COURT SQUARE. ASPHALT.
LOCUST NEAR BEAUMONT. ASPHALT.
BROADWAY NEAR OLIVE. GRANITE.
PINE AND GARRISON. ASPHALT.
CHESNUT AND BEAUMONT. WOOD.
OLIVE AND BEAUMONT. GRANITE.
LONDON
NEW YORK
CHICAGO
BOSTON
ST. LOUIS
EXHIBIT NO. 23.

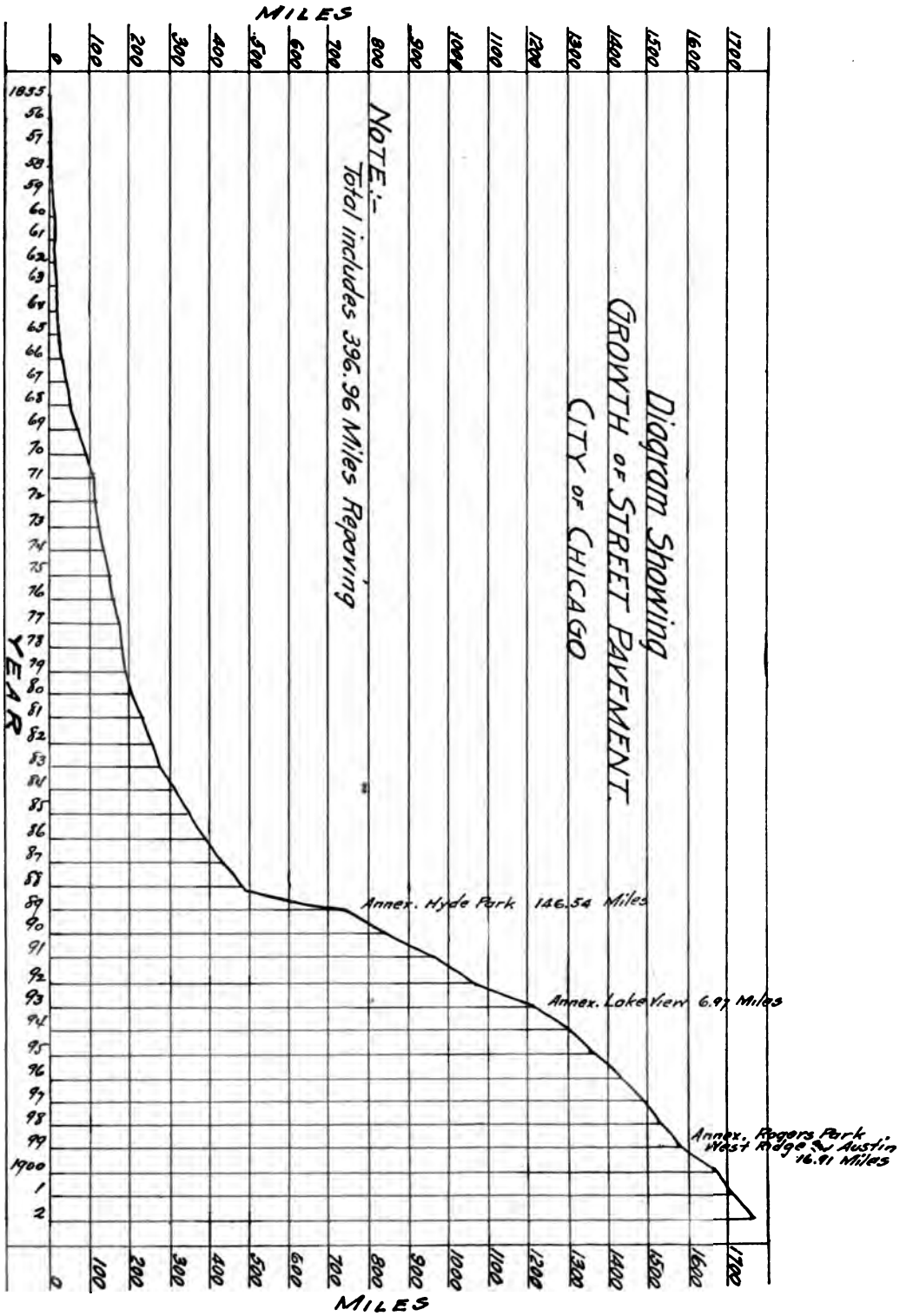
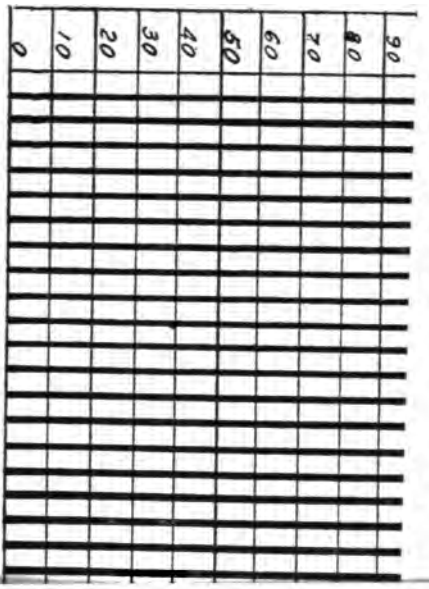
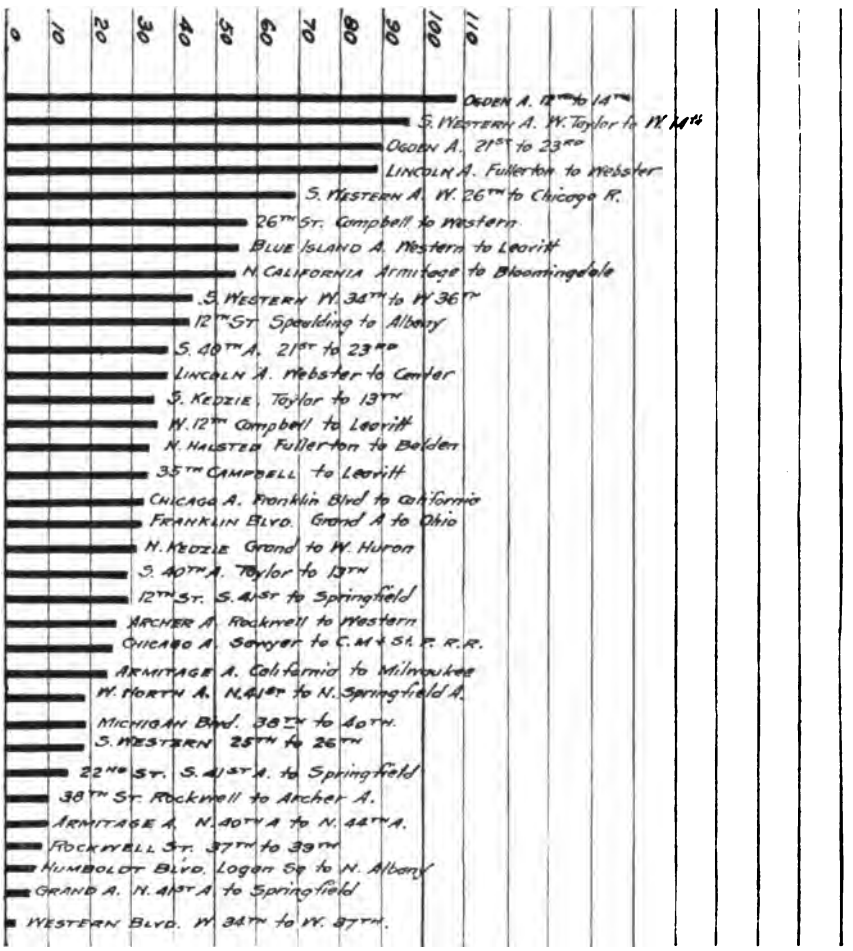
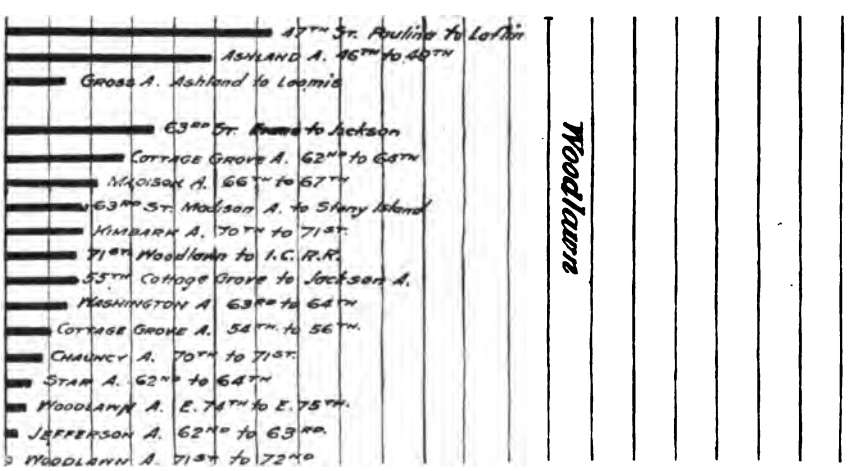


EXHIBIT No. 24.

TRAFFIC IN TONS

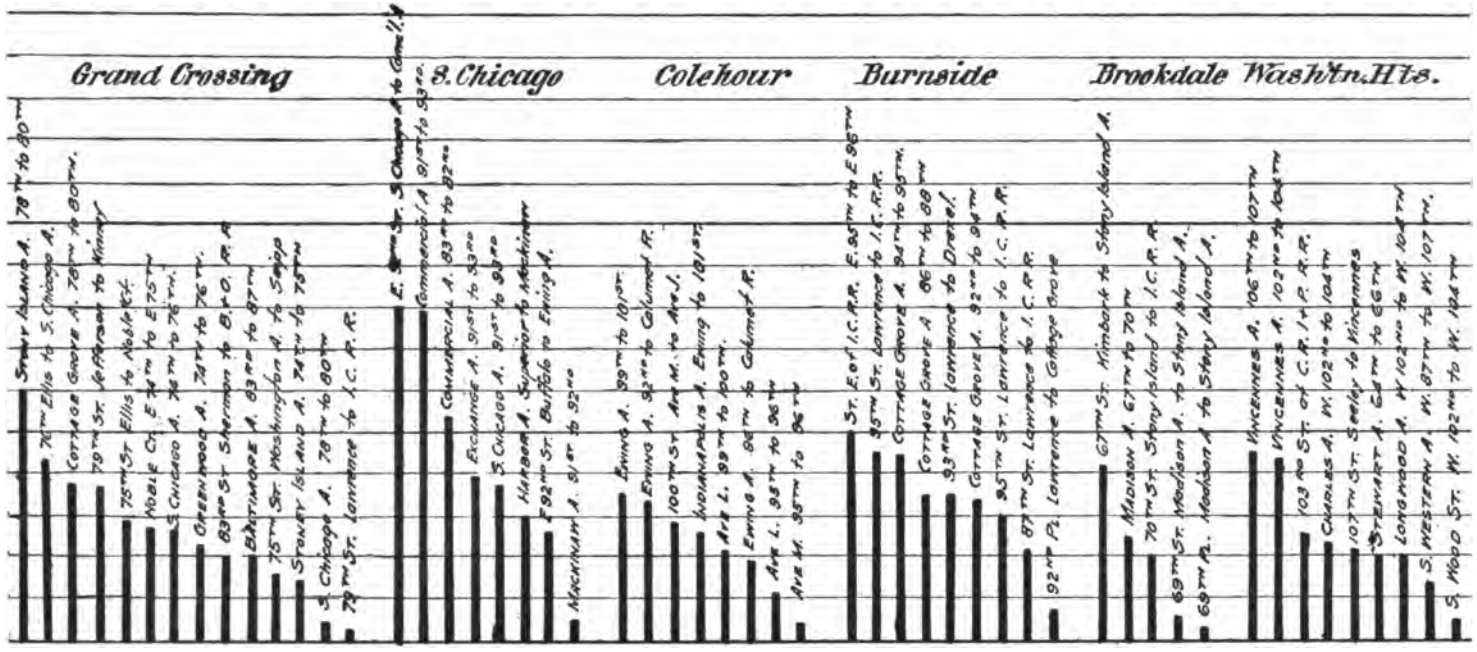



0
10
20
30
40
50
60
70
80
90
100
110
OGDEN A. 12TH to 14TH
S. WESTERN A. W. Taylor to W. 14TH
OGDEN A. 21ST to 23RD
LINCOLN A. Fullerton to Webster
S. WESTERN A. W. 26TH to Chicago R.
26TH ST. Campbell to Western
BLUE ISLAND A. Western to Leavitt
N. CALIFORNIA Armitage to Bloomingdale
S. WESTERN W. 34TH to W. 36TH
12TH ST. Spaulding to Albany
S. 40TH A. 21ST to 23RD
LINCOLN A. Webster to Center
S. KEDZIE, Taylor to 13TH
W. 12TH Campbell to Leavitt
N. HALSTED Fullerton to Belden
35TH CAMPBELL to Leavitt
CHICAGO A. Franklin Blvd to California
FRANKLIN BLVD. Grand A to Ohio
N. KEDZIE Grand to W. Huron
S. 40TH A. Taylor to 13TH
12TH ST. S. 41ST to Springfield
ARCHER A. Rockwell to Western
CHICAGO A. Sawyer to C. M & St. P. R.R.
ARMITAGE A. California to Milwaukee
W. NORTH A. N. 41ST to N. Springfield A.
MICHIGAN Blvd. 38TH to 40TH.
S. WESTERN 25TH to 26TH
22ND ST. S. 41ST A. to Springfield
38TH ST. Rockwell to Archer A.
ARMITAGE A. N. 40TH A to N. 44TH A.
ROCKWELL ST. 37TH to 39TH
HUMBOLDT BLVD. Logan Sq to N. Albany
GRAND A. N. 41ST A to Springfield
WESTERN BLVD. W. 34TH to W. 37TH.


47TH ST. Pauline to Laflin
ASHLAND A. 46TH to 49TH
GROSS A. Ashland to Loomis
63RD ST. Ruan to Jackson
COTTAGE GROVE A. 62ND to 64TH
WOLCOTT A. 66TH to 67TH
63RD ST. Madison A. to Stony Island
KIMBARK A. 70TH to 71ST.
71ST Woodlawn to I.C. R.R.
55TH Cottage Grove to Jackson A.
WASHINGTON A. 63RD to 64TH
COTTAGE GROVE A. 54TH to 56TH.
CHAUNCY A. 70TH to 71ST.
STAR A. 62ND to 64TH
WOODLAWN A. E. 74TH to E. 75TH.
JEFFERSON A. 62ND to 63RD.
WOODLAWN A. 71ST to 72ND
Woodlawn

DISTRICT NO. 3.

Bounded by District No 2 & the City Limits



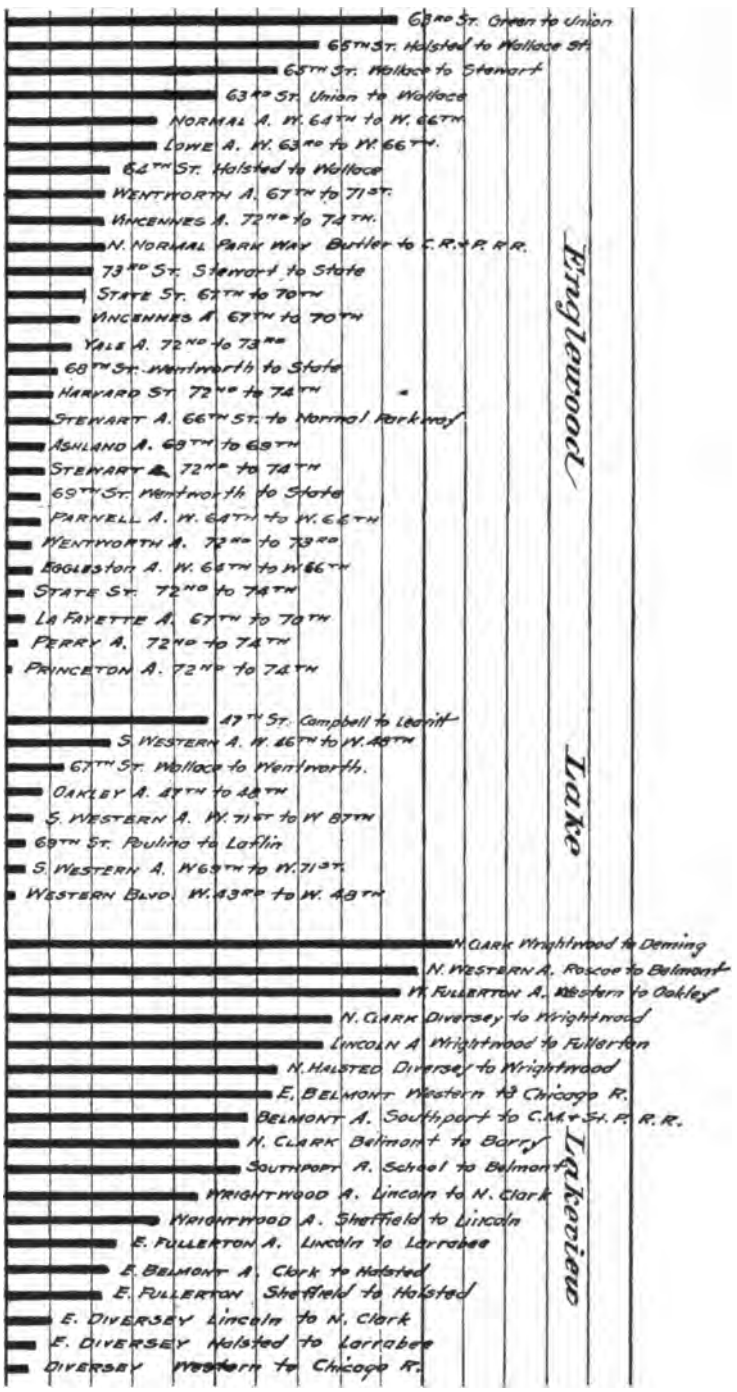

Englewood
63rd St. Green to Union
65th St. Halsted to Wallace St.
65th St. Wallace to Stewart
63rd St. Union to Wallace
NORMAL A. W. 64th to W. 66th
LOWE A. W. 63rd to W. 66th.
64th St. Halsted to Wallace
WENTWORTH A. 67th to 71st.
VINCENNES A. 72nd to 74th.
N. NORMAL PARK WAY Butler to C.R.&P. R.R.
73rd St. Stewart to State
STATE St. 67th to 70th
VINCENNES A. 67th to 70th
YALE A. 72nd to 73rd
68th St. Wentworth to State
HARVARD ST. 72nd to 74th
STEWART A. 66th St. to Normal Parkway
ASHLAND A. 69th to 69th
STEWART A. 72nd to 74th
69th St. Wentworth to State
PARNELL A. W. 64th to W. 66th
WENTWORTH A. 73rd to 73rd
EGGLESTON A. W. 64th to W. 66th
STATE St. 72nd to 74th
LA FAYETTE A. 67th to 70th
PERRY A. 72nd to 74th
PRINCETON A. 72nd to 74th
Lake
47th St. Campbell to Leavitt
S. WESTERN A. W. 46th to W. 48th
67th St. Wallace to Wentworth.
OAKLEY A. 47th to 48th
S. WESTERN A. W. 71st to W. 87th
69th St. Paulina to Loflin
S. WESTERN A. W. 69th to W. 71st.
WESTERN BLVD. W. 43rd to W. 48th
Lakeview
N. CLARK Wrightwood to Deming
N. WESTERN A. Roscoe to Belmont
W. FULLERTON A. Western to Oakley
N. CLARK Diversey to Wrightwood
LINCOLN A. Wrightwood to Fullerton
N. HALSTED Diversey to Wrightwood
E. BELMONT Western to Chicago R.
BELMONT A. Southport to C.M.&St.P. R.R.
N. CLARK Belmont to Barry
SOUTHPORT A. School to Belmont
WRIGHTWOOD A. Lincoln to N. Clark
WRIGHTWOOD A. Sheffield to Lincoln
E. FULLERTON A. Lincoln to Larrabee
E. BELMONT A. Clark to Halsted
E. FULLERTON Sheffield to Halsted
E. DIVERSEY Lincoln to N. Clark
E. DIVERSEY Halsted to Larrabee
DIVERSEY Western to Chicago R.

EXHIBIT No 25

TONS PER FOOT WIDTH OF ROADWAY
PER DAY [12 HRS]